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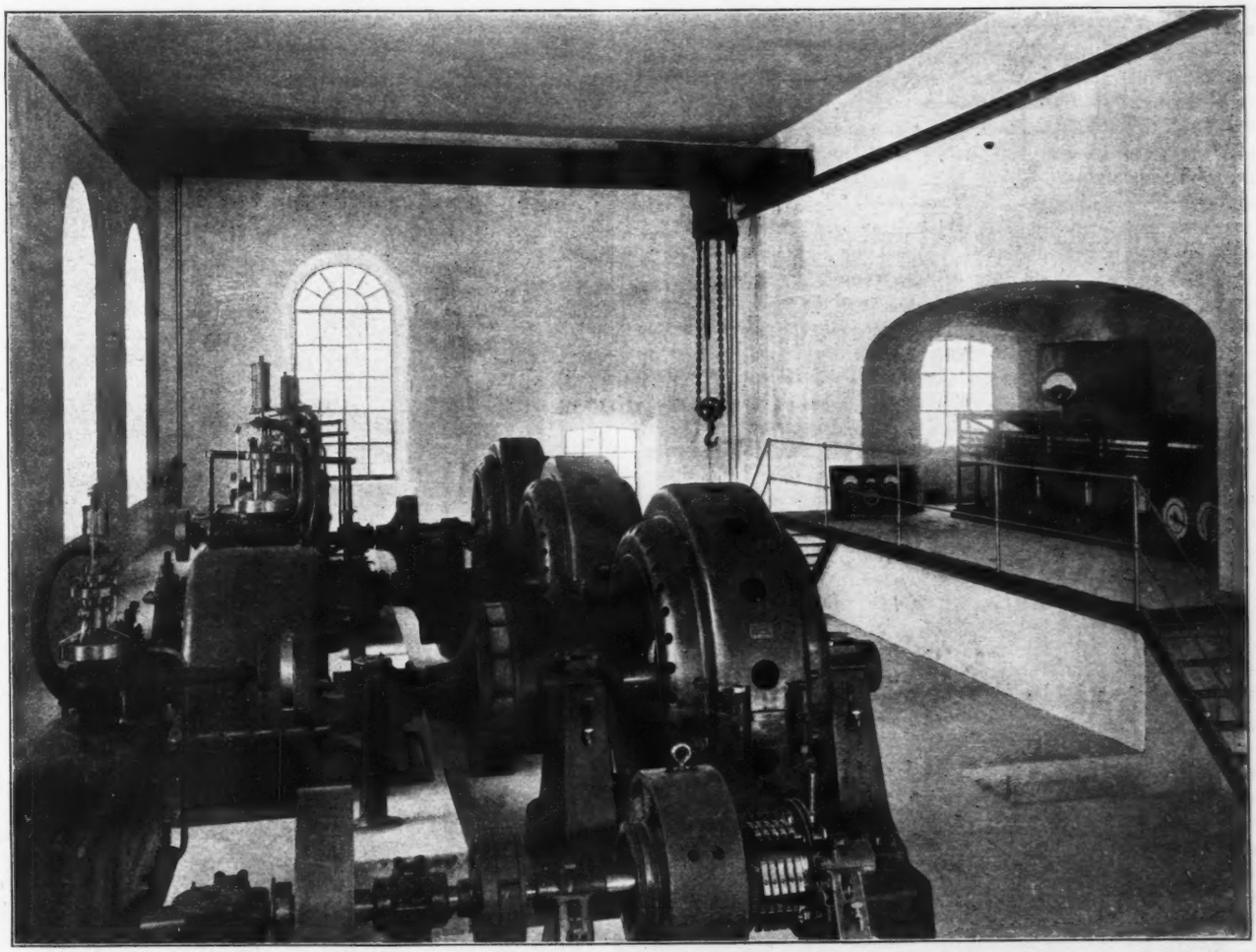
A Southern European Water Power Transmission System.

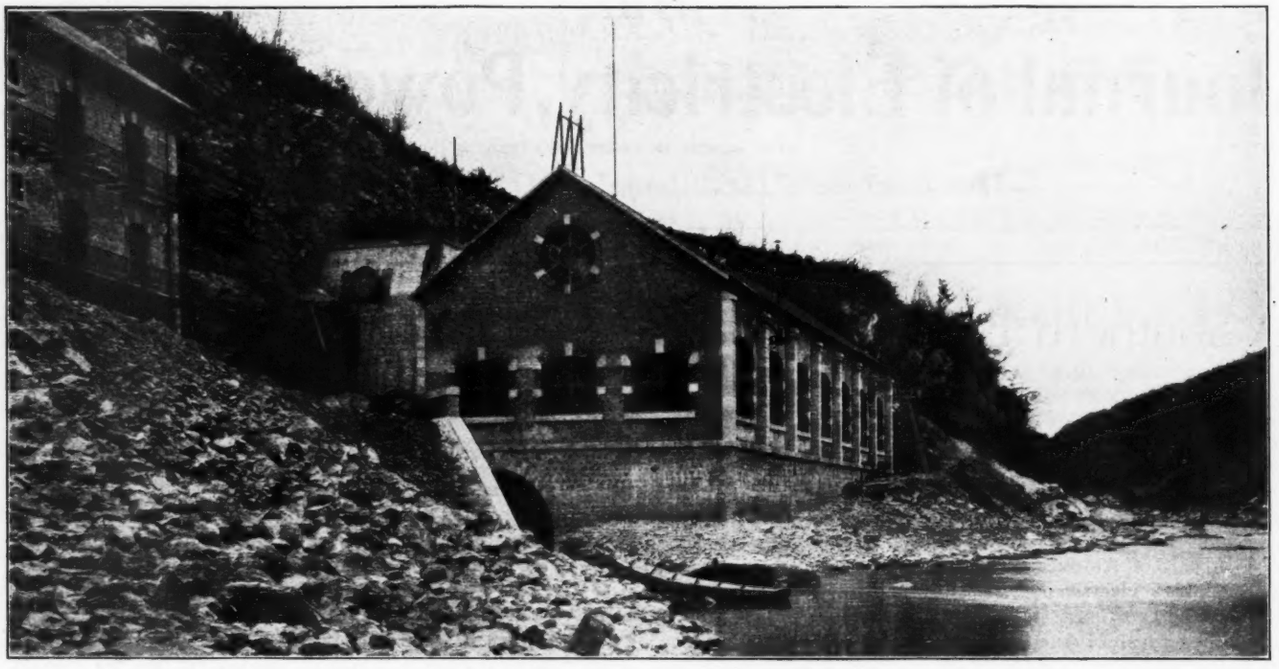
While on the Pacific Coast electric power from water plants is perhaps most largely used for mining operations, particularly in districts near the generating stations, in the eastern part of the United States many large plants have been installed primarily to furnish power for mills and factories. The utilization of electrical energy, generated from water power in Europe is perhaps more nearly like that of the eastern part of America. It is generally true that for commercial work electric power is now more largely utilized in France and Northern Italy in manufacturing plants than is any other form of energy. Of course, the mining of the various ores of every description in Europe is now carried on extensively with electricity, using both alternating and direct current. In many cases electric power derived from mountain streams is the principal source of energy, particularly in the mountains of Italy.

One of the most interesting electric power transmission systems in operation in Southern Europe consists of the power plants at Gromo in Italy and Saut-Mortier in France. The Gromo power station supplies current to the sub-station 22 miles distant, at a pressure of 40,000 volts. The interior of this generating station and floor plan is shown in the illustrations. The power house has been designed for three units of 1,000 horsepower each and two exciter units.

Water is taken from the River Serio, one of the mountain streams in the Italian Alps which have been so extensively utilized as sources of water power in that country. The turbines run at a speed of 500 revolutions per minute, each turbine directly driving a three-phase, 12-pole alternator of the Brown, Boveri & Co. type. These alternators generate current of 4,000 volts at a frequency of 50 cycles per second. Exciting current is supplied by two 25 kilowatt ma-



THE GROMO GENERATING STATION.



THE SAUT-MORTIER POWER HOUSE.

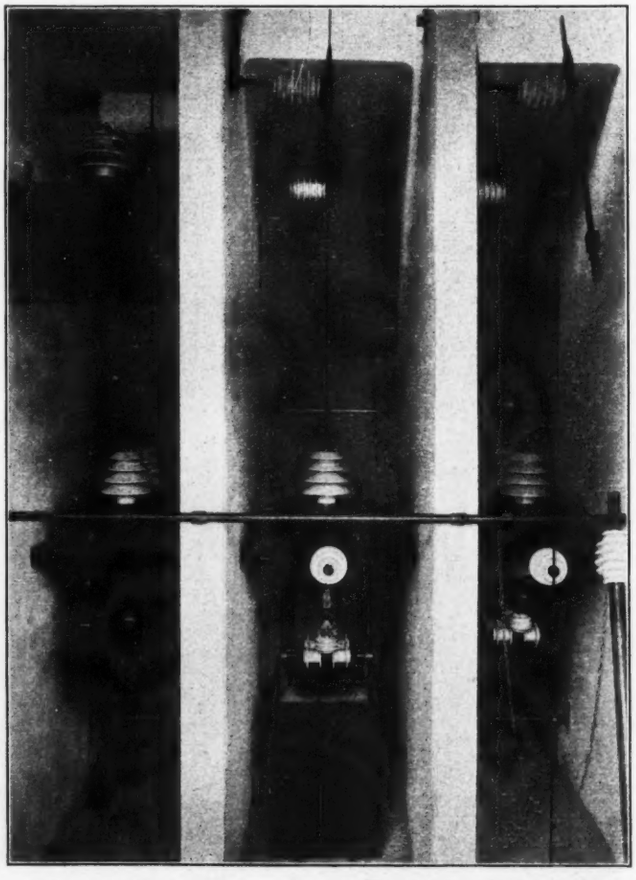
chines, each of which delivers about 220 amperes at 115 volts. The exciters are directly driven by turbines at a speed of 800 revolutions per minute. Each exciter is supplied with an automatic governor of the Eischer Wyss type, similar to the governors controlling the speed of the main units.

The generating voltage is raised to the line voltage 40,000 volts by oil insulated water cooled step-up transformers, there being six of these, each having a normal capacity of 850 kilowatts. The transmission line consists of three copper conductors, each .256 inches in diameter, supported by porcelain insulators, which have been submitted to a test voltage of 75,000 volts.

The transformer house, which is 33 feet long and 23 feet wide, is built three stories in height, the lightning arresters and high tension conductors being arranged on the top floor, while the second floor contains the switchboards, high tension switches and measuring instruments, and the lower floor the transformers. The transmission line is built over a very rough country, as is shown in the illustration. Wooden poles are used, spaced on an average of 131 feet apart, the height of the poles being such that the insulators and cross-arms are uniformly about 33 feet above the ground. At Nembro, the end of the transmission line, the sub-station contains three step-down transformers, each having a capacity of 500 kilowatts. The secondary voltage is 500 volts, and at this pressure the current is utilized on all of the distributing circuits.

In the generating station and in the sub-station the 40,000 volt oil switches are each mounted in separate cells or chambers constructed of concrete. The switchboard gallery of the power station is installed at one side of the building in a separate room provided especially for the controlling apparatus. The general design of the building is most convenient, and with the high tension transformers located in a separate building, the fire hazard is reduced to a minimum. Each of the turbines is directly connected to its alternator by a flexible leather link coupling. The same type of coupling is also used in the exciter units. A flywheel is added to each unit in addition to the automatic regulator to provide a practically constant speed notwithstanding wide variations of load.

A second sub-station is located at St. Claud and this sub-station is connected on its high tension side with the French hydro-electric station at Saut-Mortier. Water for this latter plant is taken from the River Ain, which rises in the Jura mountains and ultimately empties into the River Rhone. The water supply varies from 250 cubic feet per second as a maximum to 140 cubic feet per second as a minimum, de-



THE 40,000 VOLT SWITCHES IN THE GROMO GENERATING STATION.

THE 40,000 VOLT GROMO TRANSMISSION LINE.

pending upon the season of the year. The Saut-Mortier generating station is equipped with electric generators and switchboards of the Oerlikon type.

In this plant advantage has been taken of Lake de Chalain, which is utilized as a reservoir. In this lake there is stored about 700,000,000 cubic feet of water. The normal flow is such that with the head available 60 feet more than 3,000 horsepower may be developed. From the intake the water is conducted to the power house through a canal 5,000 feet long, where it enters the entrance canal at the power house. Three sluiceways each three feet deep and six feet wide convey the water from the canal to the power house. The pressure pipes are constructed of steel three-tenths of an inch in thickness and are 6 feet 9 inches in diameter.

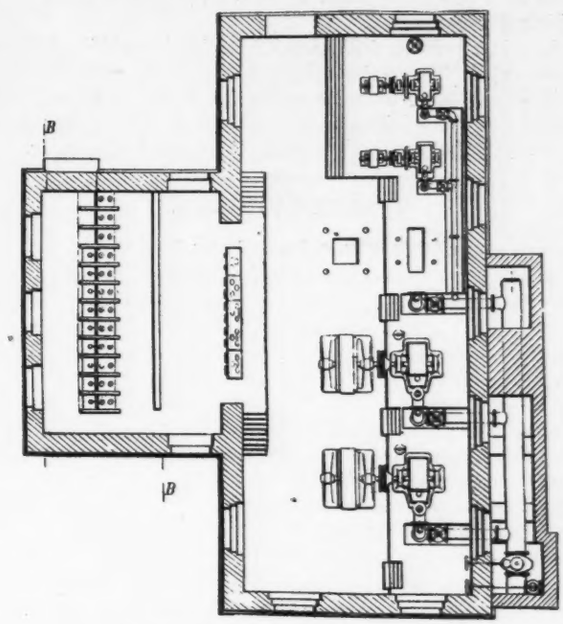
The power house is 114 feet long and 48 feet wide, and is designed for four units, each having a capacity of 500 kilowatts. The turbines are directly connected to the alternators and the units run at a speed of 250 revolutions per minute. Flexible couplings of the Rafford type are used for connecting the turbines to the generators. The speed is controlled by governors of the Piccard type, giving excellent speed regulation.

The alternators, which are of the rotating field type, deliver current at 7,500 volts, the frequency being 50 cycles per second. The efficiency of these machines at normal load is given at 93.5 per cent. The exciters, which have a normal capacity of 36 kilowatts, deliver exciting current at 30 volts to the main generators. The rheostats, lightning arresters, fuses and main bus-bars are located in a room directly under the switchboard gallery.

The transmission line from the power station to the substation at St. Claud is 16 miles long. Two complete circuits are installed, each circuit consisting of three conductors, the diameter of each being .315 inches. A second transmission line from the power station to the town of Montau is 5.6 miles in length, there being one three-phase circuit. From this line branch lines are taken to Belignet, Montreal and Marchon. A third high tension line from the power house goes to Arinthod, five miles in length. A fourth to Cernon is three miles and a fifth to Morians is six miles long.

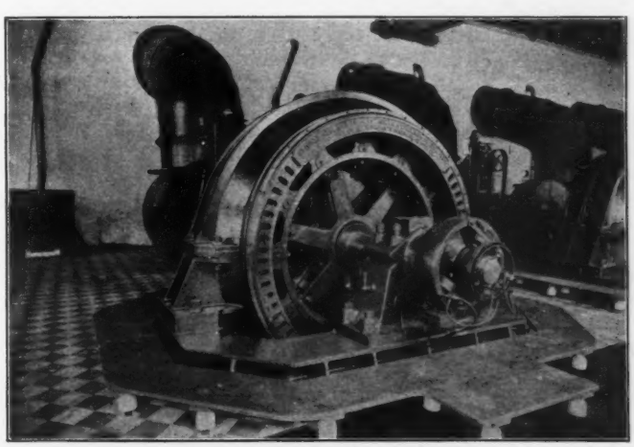
The aggregate length of all the high tension transmission lines of the system is 93 miles, the total number of poles in the lines being approximately 4,000.

In the St. Claud sub-station there are four transformers, each having a normal capacity of 700 kilowatts. In this substation are installed a number of motor generating sets. Each three-phase motor is directly connected to two direct current dynamos, one on either end of the motor shaft, the capacity of each direct current generator being 60 kilowatts. These run at a speed of 590 revolutions per minute and supply continuous current at 200 volts.



PLAN OF GROMO POWER STATION.

A recently completed water power plant of considerable interest is located at Turbigo, Italy. The power house is situated on the left bank of the Ticino river, about 15.5 miles from Lake Maggiore and a short distance below Tornavento. The canal which delivers water to this plant is approximately 31 miles in length and is navigable. The water from this canal is also used for irrigation in Lombardy, furnishing water to a large and fertile country near Pavia and Milan. The canal is so constructed that it has a fall of 95 feet in the first 18 miles and 15 feet in the remaining 13



THE SAUT-MORTIER GENERATING STATION.

miles, thereby making a total fall of 110 feet in the entire length of the canal. The flow of water in the water conduit is not uniform throughout its entire length, as a large amount is required for irrigation along the line of the canal.

The power house is constructed in two separate portions, one for the turbines and the other for the electrical equipment. The available head is 27 feet, which with the amount of water available will develop 5,000 brake horsepower. The electric equipment consists of five alternators, four of which are for continuous operation, one being held in reserve. Each alternator delivers three-phase current at 11,000 volts and is directly coupled to a horizontal type 1,500 horsepower turbine. Each turbine is provided with an automatic regulator to control the speed, which is normally 105 revolutions per minute. The exciters, of which there are two, are each driven by a 100 horsepower turbine directly connected to its exciting generator.

The low tension distribution circuits from this plant are all 200 volts. Three-phase induction motors are used, varying in size from ½ to 35 horsepower. In all there are 85 individual motors working in the various factories, the aggregate output of these motors being about 700 horsepower.

STREET LIGHTING.

[CONTINUED FROM PAGE 174.]

Methods of Improving Street Lighting.—The remainder of my paper I propose to give up to discussing the possibilities of improving the existing state of affairs without increasing the cost in any way, and the only unit I propose to consider is the minimum illumination derived at any point. It is now several years since I came to the conclusion that the efficiency of street lighting must be judged by the minimum illumination derived at any point, in the same way that the strength of a chain is decided by its weakest link; in fact, the lighting of a street is similar to a chain of links, and in order to strengthen these links at their weakest point, I devised fittings to increase the light at that point. By far the most efficient of these, which is fully protected, is now being manufactured by the Reason Manufacturing Company of Brighton, and as it will enter largely into the figures I propose to put before you, I will describe it in order that you may see that the excellent results, which I am able to guarantee, are obtained by utilizing the rays of light which would otherwise be lost. I might mention that there are several thousand of these fittings in use, and that they have been the means of obtaining the street lighting contract for the electricity department in many cases.

These fittings are arranged in many different forms to suit special positions, but by far the most efficient is the one which is intended for straight roads, for which the bulk are required.

In designing these fittings, I took the following facts into consideration:

1. That the rays directed above the horizontal are useless, and therefore can be diverted up and down the street to increase the distant illumination.

2. If the posts are erected on the edge of the footpaths, the rays which would illuminate the adjacent houses or fields are practically useless, unless the houses have a reflecting value, which is very rarely the case.

3. The rays of light illuminating the street near the post should be of small value compared to those directed to a distance up and down the street, in order to obtain even illumination.

The above conditions, in short, mean that practically only a quarter of the mean spherical candle power is useful, and that the other three-quarters are wasted unless directed into the required direction. The extent to which this fitting succeeds is as follows:

The average candle-power of the lamps measured from all parts of the street will be found to be 2.2 times the mean spherical candle-power, and the maximum candle-power measured over the width of the road some distance from the post is nearly three times the mean spherical, the minimum candle-power measured adjacent to the post being equal to the mean spherical candle-power of the lamps.

One-half of the filaments or glowers of each of these lamps is enclosed in a specially shaped hollow hemispherical reflector, fixed at such vertical and horizontal angles that in those positions (as viewed from the street) where the reflectors are not in themselves increasing the illuminating value of the lamps to more than double the maximum of one lamp, the light of both lamps is allowed to shine. Thus, at no point does it decrease the light, and over the greatest area of the street the light is increased to the maximum above stated.

These reflectors are of glass blown on to a mould of the correct shape, and in such a way as to form a bottle, the inside of which is silvered; the opening is then hermetically sealed when fixing the cap; thus a reflector of about 88 per cent efficiency is obtained—which efficiency is practically permanent.

You will note that in the reflector the whole of the hemispherical rays are deflected, whereas in previous designs in which the lamp passed through a hole in the center of the reflector a great number of these rays were not utilized. Another point is that the lamps are in such a position that the maximum rays are used both in illuminating the distant parts of the street direct, and by means of the reflector.

Table II. gives the average multiplying power of the author's reflector fitting as made by the Reason Manufacturing Company, the unit of light being taken as the mean spherical candle-power of the two lamps used in the fitting; the angles at which this factor is given being the useful angles for street lighting; o° horizontal coinciding with the kerb of the pavement.

TABLE II.

Vertical Angle	Horizontal Angles	Multiplying Factor
30° (from horizontal)	90° (across street)	1.05
" "	70° "	1.5
15° "	50° "	2.3
" "	30° "	3.0
" "	10° "	3.0
" "	0 (kerb line)	3.0
" "	10 (house side)	1.6
30 "	30 "	0.85
" "	50 "	0.6

It will be seen from this table that, provided the lamps are adjusted correctly in the reflectors, the increase of street illumination derived by the use of the reflector fittings will be much higher than claimed, but taking into consideration extra globes, etc., the maximum multiplying factor can be taken as 2.5.

These fittings are free from what is sometimes called "the bull's-eye" effect, as the maximum rays are not concentrated into anywhere near a parallel beam, but are spread over an agle of 20°, and rays equal to twice the mean spherical candle-power of the two lamps are spread over an angle of 40°, which is generally the whole width of the road at a distance equal to twice the height of the post.

Best Means of Illuminating Different Classes of Streets.—In order to ascertain the most suitable type of lamp to use for the purpose, when basing calculations on minimum illumination it is necessary to know the candle-power derived from the lamps at an angle of about 20 to 30 degrees below the horizontal, and about 10 degrees on the path side, and 30 degrees on the road side, of an imaginary line drawn parallel to the curb; this is, of course, for posts erected on either side of the road, which is the present-day practice. For lamps giving an equal candle-power at all parts of the lower hemisphere, this figure will, of course, be the same as the mean hemispherical candle-power; but for lamps such as arc lamps, gas mantles, various types of Nernst lamps, and special reflector fittings, it must be taken from actual measurements, made at the various angles.

As many of you have probably not the opportunity of making these measurements, I submit the following table, No. III, which is based on the average of a large number of measurements made in the street under working conditions.

TABLE III.

showing average mean candle-power of lamps 20° to 30° below horizontal, and 10° one side and 30° the other side of a line drawn parallel to the street.

Electric Lamps	Watts Consumed per Hour	Candle Power at Angles Stated
1 Flame Type	400	1,300
2 Open-type Arc	500	500
3 Enclosed Arc	1,000	1,100
4 "	600	550
5 Reason Fitting Incandescent Lamps	200	120
6 " "	120	70
7 " "	60	30
8 Reason Fitting Tantalum Lamps	70	110
9 Nernst Lamps "A" Type	100-120	40
0 Nernst Lamps "B" Type	50-60	15
Gas Lamps.	**Gas Consumed per Hour**	**Candle Power at Angles Stated**
11 High-pressure Mantles	30 c. f.	515
12 " "	20 c. f.	215
13 Intensified Gas, 2 Mantles (City)	7·5	130
14 2 Low-pressure Gas Mantles	7·5	75
15 1 Low-pressure Gas Mantle	3·75	37

In order to ascertain the gas consumption of the high-pressure mantles, Nos. 11 and 12, and of the intensified mantle, No. 13, I have had to go by the figures in the Gas Journals, in which No. 1 is generally stated as 1,000 candle-power, giving 30 candles per cubic foot, and No. 2 as 600 candle-power of the same consumption. The candle-powers given are the average of a large number of measurements I have made, which agree very closely with measurements made by others. But I would particularly call attention to class 13, which is scheduled under intensified gas, and appears unduly high. In my opinion this is due to the mantles being renewed at more frequent intervals, as it is based on measurements made in Fleet street, which, it must be borne in mind, is what may be called without prejudice a test case.

It is now comparatively easy to set down the numbers of posts and fittings per mile necessary to obtain the minimum illumination generally provided for various classes of streets, but in order to facilitate this process it is well to have before you a further table, showing the direct illumination derived at various distances from a lamp giving 1 candle-power at that point; with this it is only necessary to find the figure which when multiplied by the various candle-powers gives the required illumination and then by turning to the distance column and multiplying it by two the resulting figure will be the distance separating the posts.

A statement worked out in this way will be found in Table IV., the reference numbers relating to the lamps being the same as in Table III.

TABLE IV.

DISTANCE APART OF LAMPS OF VARIOUS TYPES TO GIVE REQUIRED MIN. ILLUMINATION

Type of Lamp.	Main Thoroughfares, Min., 0·05 c. p. f.		Side Streets 0·025 c. p. f.		Suburban Streets 0·005 c.p.f.	
	Distance apart Feet.	Posts per 1,000 yds.	Distance apart Feet.	Posts per 1000 yds.	Distance apart Feet	Posts per 1,000 yds.
1. Electric Flame	300	10	.....	.....	.....	.....
2. Open Arc.....	200	15	.....	.....	.....	.....
3. Enclosed Arc..	300	10	.....	.....	.....	.....
4. " "	200	15	300	10	.....	.....
5. Reason Fitting	100	30	140	21	300	10
6. " "	70	43	100	30	450	13
7. " "	45	66	65	46	150	20
8. " "	90	33	130	23	290	10
9. Nernst Lamp.	55	54	75	40	180	17
10. " "	.....	.....	45	67	110	27
Gas Lamps.						
11. High Pressure	200	15	300	10	.....	.....
12. " "	120	25	180	17	.....	.....
13. Intensified.....	100	30	140	21	.....	.....
14. Ordinary	75	40	105	28	240	12
15. "	50	60	75	40	170	17

It must be quite understood that the above table is only approximate, and that it and the following table, of which it forms a factor, are therefore simply for comparative purposes.

From Table IV it is easy to calculate the quantity of electrical energy and gas consumed for illuminating 1,000 yards of streets, up to the various standards necessary with the illuminants at one's disposal; and if electrical energy be taken at 1½d. per Board of Trade unit, and gas at 2s. per 1,000 cubic feet, a very useful table of comparative costs is arrived at. In order to make this approximately annual cost, I have taken the burning hours at 4,000; the results are given in the following table:

TABLE V.

No. of System	Main Streets		Side Streets		Suburban Streets	
	Elec. Units	£ s. d.	Elec. Units	£ s. d.	Elec. Units	£ s. d.
1	16,000	100 0 0	.....	.....	.....	.....
2	30,000	187 10 0	.....	.....	.....	.....
3	40.000	250 0 0	.....	.....	.....	.....
4	36,000	225 0 0	24,000	150 0 0	.....	.....
5	24,000	150 0 0	16,800	105 5 0	8,000	50 0 0
6	20,640	129 5 0	14,400	90 0 0	6,240	38 11 0
7	15.800	98 15 0	11,000	68 15 0	4,800	30 0 0
8	9,000	56 5 0	6,440	40 5 0	2,800	17 10 0
9	24,000	150 0 0	18,000	112 10 0	7,480	46 15 0
10	.....	.....	15,000	93 15 0	6,000	37 10 0
	Gas 1,000 c. f.		Gas 1,000 c.f.		Gas 1,000 c.f.	
11	1,800	180 0 0	1,200	120 0 0	.....	.....
12	2,000	200 0 0	1,360	136 0 0	.....	.....
13	900	90 0 0	630	63 0 0	.....	.....
14	1,200	120 0 0	840	84 0 0	360	36 0 0
15	900	90 0 0	600	60 0 0	255	25 10 0

This table may create great surprise in the minds of many, but it is absolute proof of a theory which very few people realize, namely, that the more the light is broken up into small units, the more efficient will be the general illum-illumination, but it has not been applied to outdoor illumina-ination; this fact has been appreciated as regards indoor tion; before saying any more on this point I will pass on to the next detail, namely, the cost of maintenance of the various types of lamps.

This, again, I have gathered from various sources, but as the interest and sinking fund on mains and services is very rarely charged to the street lighting, I propose to leave out this item for the present; on the other hand, I include interest and sinking fund on all apparatus proper, including the posts. It has been difficult to obtain any reliable information regarding high pressure gas lamps, but I have included an average of that which I have been able to obtain.

TABLE VI.

giving maintenance charges, including renewals, cleaning, lighting and extinguishing, interest and sinking fund, but excluding cost of electrical energy and gas. Extended over a period of 4,000 hours.

		£ s. d.
(1)	Electric Flame Arc (long burning).....	9 0 0
(2)	" Open Arc	9 0 0
(3)	" Enclosed Arc	4 10 0
(4)	"	4 0 0
(5)	" Reason Fitting	1 0 0
(6)	"	1 0 0
(7)	"	1 0 0
(8)	" Reason Tantalum Lamps	2 15 0
(9)	" Nernst Lamps	1 2 0
(10)	"	1 2 0
(11)	Gas High-pressure Mantles	7 0 0
(12)	"	5 10 0
(13)	" Intensified	2 5 0
(14)	" 2 Low-pressure Mantles	1 15 0
(15)	" 1 Low-pressure Mantle	1 10 0

Note.—The maintenance for both gas and electric lamps will, of course, vary in accordance with local conditions, but the above can be taken as a fair average when bearing in mind that the small candle-power lamps refer more particularly to small towns and the large lamps to larger towns.

If the above costs be added to those in the preceding Table V, we get the results shown in Table VII, which will give the average total cost per annum for all night lighting of 1,000 yards of streets, under the various requirements and conditions of lighting.

TABLE VII.

Total Cost Per Annum (4,000 Hours) Per 1,000 Yards of Street.

System.	Supply. £ s. d.	Maintenance. £ s. d.	Total £ s. d.
Electric—		Main Streets.	
(1)	100 0 0	90 0 0	190 0 0
(2)	187 10 0	135 0 0	322 10 0
(3)	250 0 0	45 0 0	295 0 0
(4)	225 0 0	60 0 0	285 0 0
(5)	150 0 0	25 0 0	175 0 0
(6)	129 5 0	43 0 0	172 0 0
(7)	98 15 0	66 0 0	164 15 0
(8)	56 5 0	100 15 0	157 0 0
(9)	150 0 0	59 8 0	209 8 0
(10)	—	—	—
Gas—		Main Streets.	
(11)	180 0 0	105 0 0	285 0 0
(12)	200 0 0	137 10 0	337 10 0
(13)	90 0 0	67 10 0	157 10 0
(14)	120 0 0	70 0 0	190 0 0
(15)	90 0 0	90 0 0	180 0 0
Electric—		Side Streets.	
(1)	—	—	—
(2)	—	—	—
(3)	—	—	—
(4)	150 0 0	40 0 0	190 0 0
(5)	105 5 0	21 0 0	126 5 0
(6)	90 0 0	30 0 0	120 0 0
(7)	68 15 0	46 0 0	114 15 0
(8)	40 5 0	63 0 0	103 5 0
(9)	112 10 0	44 0 0	156 10 0
(10)	93 15 0	50 12 0	144 7 0
Gas—			
(11)	120 0 0	70 0 0	190 0 0
(12)	136 0 0	93 10 0	229 10 0
(13)	63 0 0	47 5 0	110 5 0
(14)	84 0 0	49 0 0	133 0 0
(15)	60 0 0	60 0 0	120 0 0
Electric—		Suburban Streets.	
(1)	—	—	—
(2)	—	—	—
(3)	—	—	—
(4)	—	—	—
(5)	50 0 0	10 0 0	60 0 0
(6)	38 11 0	13 0 0	51 11 0
(7)	30 0 0	20 0 0	50 0 0
(8)	17 10 0	27 10 0	45 0 0
(9)	46 15 0	18 14 0	65 9 0
(10)	37 10 0	29 14 0	67 4 0
Gas—			
(11)	—	—	—
(12)	—	—	—
(13)	—	—	—
(14)	36 0 0	21 0 0	57 0 0
(15)	25 10 0	25 10 0	51 0 0

The foregoing tables demonstrate several interesting points, the importance of which I consider cannot be overrated. They are as follows:

1. The use of large units of light for general street illumination is expensive, and should be avoided where possible.

2. The cost of maintenance is very often as high, if not higher, than the cost of electrical energy or gas; it must be borne in mind that in the foregoing table electrical energy is taken at 1½d. per unit—it is very often less than this for street lighting, in which case the cost of maintenance becomes a still more important factor.

Possible Improvements.—Before concluding, I should like to give my opinion of the directions in which I believe improvements are likely to be made with existing electric lamps and apparatus for the particular purpose under consideration. These are:

1. Improvements in the methods of connecting and controlling electric lamps.

2. Reduction in maintenance costs.

3. Correct disposition of lamps and choice of suitable fittings, etc.

Improvement No. 1 is probably the one which should be and must be dealt with when street lighting installations are being originated. It is by far too common a practice to connect street lighting across the ordinary distributors in the same way as gas lamps are connected to the existing gas mains. In the case of gas lamps, nothing could be gained by adding to the usual mains, as it is essential that each lamp should be lighted individually, without any complicated or wasteful ignition apparatus being used. With electric lamps quite another condition of affairs exists. A saving of at least 6s. per post, which sometimes amounts to 15s. per annum, can be made by using a separate network, and if this street lighting network is laid on a suitably designed basis, such as that used by Mr. Wilkinson of Harrogate, a considerable saving results.

Methods of Connecting Street Mains.—Mr. Wilkinson has kindly given me particulars of the system of street lighting mains which he has recommended for Harrogate; briefly described, it consists of laying unarmoured cables in steel tubing situated underneath the flags or paving adjacent to the curbstones. Not only does this system dispense with the cost of excavating, but also has the advantage that the pipes and mains are in a fairly dry and accessible place, and can be laid without causing street obstruction. For the purpose of comparison I have drawn up Table No. VIII, giving the approximate cost of mains and services for 1,000 yards of street, providing for 38 posts placed on one side of the road only; you will notice that I have given both series and parallel systems of connecting the lamps, for reasons I will describe later.

Note.—In the series system it is taken for granted that the street mains are connected to a distributor or feeder at each end of the street. From the above table it will be seen that, provided a suitable system of mains is used, the sinking fund will in no way approach the cost of separate switching, which point, combined with the advantages of central control, tends to the conclusion, in my mind, that a separate network should be put down where possible.

Choice of Lamps.—It will probably have been noticed that the highly efficient incandescent types of lamps which are now being put on the market such as tantalum and osmium, are much more suited for low voltage than high; in fact, the high prime cost and reduced lasting powers of these lamps is largely due to the attempts the makers have made (by reducing the sectional area and increasing the lengths of the filaments) to adapt them to the existing pressures of supply undertakings. Now, these lamps, provided their lasting properties are improved, are eminently suited for street lighting, on account of their high efficiency and steady light-giving power.

I have therefore lately been experimenting with these lamps connected in series with most gratifying results, and trust shortly to be able to recommend the supply of these lamps for street lighting purposes. They will be of low voltage (10 to 30), with thick filaments, intended to be run in series throughout the street, controlled at the end of each series by a magnetic relay switch connected to the previous series, in a similar manner to that used for arc lighting by Mr. Robinson of Hackney and others. A very simple cut-out designed by myself prevents a fault in any lamp extinguishing the series.

TABLE VIII.

System.	Cost per 1,000 Yards.	Interest and Sinking Fund at 6 per Cent.	Interest and Sinking Fund per Post.
	£	£ s. d.	s. d.
Twin lead-covered armoured	300	18 0 0	say 9 6
Single " series	200	12 0 0	6 3
Wilkinson system parallel	100	6 0 0	3 2
" " series	75	4 10 0	2 7
Connecting to existing distributor	40	2 8 0	1 3

I will now give an example showing the cost of installation, maintenance, and supply of energy for lighting 1,000 yards of street on this principle.

Taking the average side street requiring a minimum illumination of 0.025 candle-power foot, using lamps giving a maximum of 40 candle-power in the required direction, 38 posts and lanterns would be necessary. If each of these is fitted with two osmium lamps giving 10 candle-power each, they will, with Reason reflectors, provide the necessary candle-power.

With a 440-volt distribution, the two lamps in each lantern would be connected in parallel the posts being connected in series, 11-volt lamps would, therefore, be suitable. If these are giving 10 candle-power each, the filaments would be

short and thick and would probably last several thousands of hours.

The diminution of candle-power with the osmium lamp is so small that 2,000 hours' burning per lamp should be satisfactory. The following estimate is therefore probably correct:

Capital Charges.

	£	s.	d.
Mains and services	75	0	0
38 posts erected	57	0	0
38 lanterns and reflectors.....	45	0	0
Relay switch and cut-outs, etc.....	23	0	0
	£200	0	0

Running Charges (per 4,000 hours).

	£	s.	d.
Interest and sinking fund on above at 6 p.c	12	0	0
152 lamps at 3s.	22	16	0
Cleaning, etc., at 3s. per post.....	5	14	0
4,000 units at 1½d. per unit.....	25	0	0
Total annual cost	£65	10	0
Total annual cost per post.....	£1	14	6

These figures show that even when including interest and sinking fund on all materials and mains, street lighting can be carried out at a profit by means of electricity at a price far below the average charge for gas when giving the same result as regards illumination. Moreover, this system of connecting and control is the best method of embodying improvement No. 2, as it permits of further economies, such as reduction of burning hours, dispensing with the lamps or some of them on moonlight nights. The erection of new posts makes it possible to space the lamps at the correct distance for the class of street which is to be lighted and the type of lamp to be used. You will notice I have taken 10 candle-power 11-volt lamps in the example, but it is quite conceivable that, say, 15 or 20 candle-power lamps would result in a further saving if the lamp renewals are to cost 3s. or more, though, of course, the diversity factor would be increased.

In my calculations it is easy to see that I have not favored electricity in any way. In taking the cost of gas at 2s. per 1,00 cubic feet, I have taken a price which only 12 towns out of 223 are able to charge, all the others being higher; whereas 1½ d. per Board of Trade unit is higher than is being charged by a large number of electrical undertakings.

The price at which electrical energy can be supplied at a profit for street lighting purposes has been so ably dealt with by others that I do not propose to say much on this subject, but would ask you to consider it from a somewhat novel point of view.

As you are aware, the average earning capacity of every kilowatt of plant installed is about £10 per annum. A kilowatt supplied during 4,000 hours per annum represents 4,000 units; thus in order to earn the same amount per kilowatt on a street lighting load it would only be necessary to charge 0.6d. per Board of Trade unit. I do not suppose for one moment an electrical undertaking would expect to make more out of their street lighting than out of the average supply, therefore it will be seen that in charging 1½d. per unit I have probably put the figure at more than twice what it should have been in the majority of cases. This makes the comparative cost of the two illuminants even more accentuated in favor of electricity.

In conclusion, I trust that I have been able to prove that we have at disposal in electricity a force which, if properly applied, can be used for lighting streets more efficiently and at less cost to the rate-payers than any other form of illuminant available. It rests with electrical engineers to advance this branch of our business much more rapidly than it has advanced during the last few years. I am not a believer in the proverbs that everything comes to those who wait. Street lighting will not come to those electricity undertakings the engineers of which do not use every effort to obtain it. Far too many are prepared to sit still and allow the gas companies to retain this most valuable load and even more valuable advertisement. Those who have studied the matter carefully are aware that in nine cases out of ten the lighting of the streets still remains in the hands of the gas companies, simply on account of the business push and acumen of their managers. It is surprising that gas companies in many cases retain this branch of the business when many electrical engineers are so disinterested in the matter as not to trouble to find out what can be done?

It is a very common practice to leave the choice of lamps, etc., to the lighting committee. This is not fair either to the committee or the engineer. The latter is paid to advise the committee, and see that they get the most efficient apparatus for the purpose; it is therefore wrong that he should use no effort to prevent his employers being misled by appearances. Engineers have often said to me: "The committee like the appearance of such and such a globe, therefore I have put it in to please them." Would the same engineer have put in a beam engine to drive his generators because his committee like to see the beam move up and down? Yet the effect of lighting the streets badly would ultimately prove a more serious obstacle to the success of that undertaking than even the beam engine. I would, therefore, impress upon you again the importance of not allowing one of the most valuable branches of our business to be absorbed by others, simply because they are more persevering in forcing statements and claims they cannot substantiate before the notice of those who control the lighting of our streets.

Finally, I wish to record my indebtedness to the various gentlemen who have so kindly assisted me from time to time by sending me particulars of the street lighting under their control. Also to Mr. Kent of Croydon and Mr. Fairey of Finchley for assistance in making photometric measurements in the streets, and finally to Mr. Haydon of Faraday House, who has done much of the tabulating and similar work which has been necessary in order to show the various figures of comparison.

FREQUENCY AND ELECTRIC LIGHTING.

The relation of frequency to illumination of incandescent lamps has been the subject of discussions among engineers on many occasions, and in the April issue of the Pittsburg "Electric Journal," Mr. H. B. Alverson adds his quota to the controversy. He gives the results of his experience with 25-cycle current for lighting purposes in Buffalo. The variation in current passing through the filament may have an effect upon the eye. But Mr. Alverson says it is an extremely difficult matter to detect any variation of lights in the Buffalo circuits due to flickering of incandescent lamps on a frequency of 25 cycles. The use of automatic arc lamps on 25 cycles has so far proved a failure, and Nernst lamps have not been found as efficient and reliable as on 60 cycles, but there are at present in Buffalo over 50,000 16-candle-power equivalents connected on 25-cycle circuits. The author then draws a comparison between 25-cycle and 60-cycle distribution, which works out as follows: "Given the case of an 11,000-volt 25-cycle supply available, what would be the most economical investment for a central station to distribute to its customers? If the distributing circuits are to be at 2,200 volts, there is necessary in the 25 cycle case step-down transformers only at the sub-stations, while in the 60-cycle case a motor-generator equipment is necessary. Taking all incidental matters into consideration, the difference in investment will be as 10 to 6 in favor of the 25-cycle circuit. Should the transformer capacity on the outside circuit be double the generator or transformer capacity in the sub-station, the investment will be as 10 to 8 again in favor of the lower frequency. The approaching towards equality of investment being due to the greater cost of the 25-cycle transformers over 60 cycles in the smaller sizes." It would appear from Mr. Alverson's experience that illumination by incandescent lamps at 25 cycles, in general, is quite satisfactory, but there is no assurance that it would prove satisfactory under every kind of service.

CONSOLIDATING PUBLIC POWER PLANTS.

The consolidation of lighting and power companies of small cities and towns, says the "Iron Age," issue of August 16, 1906, is becoming a more frequent occurrence. The greater economy of large stations for generating electricity and illuminating gas is given as the chief reason, although of course those who promote such consolidations by no means lose sight of the usual financial accompaniments inuring to their benefit. In many instances, however, the consolidation has been productive of some good results to the consumer in the lowering of charges for the service rendered in supplying light and power. Many small places have been supplied with these forms of public service within the past few years, each with its own plant, because of the development of combustion engines, of electrical generating equipment for use with water powers of small head and of new illuminants, especially acetylene gas. But usually the cost of the gas or electricity to the consumer has been much higher in such localities than in those having large central stations. By consolidating the electric and gas generating plants of a number of small places located within a limited area prices of the product must naturally fall, for the same reason that prices are lower in large places. Another influence is also operative in these days in the remarkable uprising of the public against high charges made by public service corporations. If consolidations do not result in cheaper service some method of compulsion is found.

As an outgrowth of these national movements there have been organized several Museums of Security; one at Vienna in 1890, one at Amsterdam in 1893, one at Munich in 1900, one at Berlin in 1901, and one at Paris in 1905, and Russia, which we are inclined to look upon as semi-barbarous, has recently established a museum on a large scale in Moscow.

That these expositions and museums have been of real value to their respective countries is evinced by a comparative study of the number of accidents in Europe and in America, which shows that for the same number of men employed in a given trade, we have from two to nine times as many accidents as they have in European countries.

The perfection of modern firearms rendered the late conflict in Asia exceptionally bloody; and yet it can be shown that without reasonable doubt the casualties of our industrial army in the United States are at least fifty per cent greater every year than the number of killed and wounded in both the Japanese and Russian armies.

Such conditions can exist only through general ignorance of their reality, and it is for the purpose of educating the public to an appreciation of the actual situation and the means of its improvement that the Exposition of Safety Devices is to be held.

The interest of manufacturers generally is solicited, as well as that of organizations whose special function is to improve the conditions of labor, and a widespread response is looked for to this request for representation in the nature of photographs, descriptive drawings, models, and as far as possible, the devices themselves in actual operation. Following are some of the groups of exhibits:

Section 1. Models, photographs and drawings of scaffolding, as well as the personal equipment of workers in building trades. 2. Protective devices for boilers, water gauges, signal apparatus, boiler and pipe valves, also protective devices for electrical machinery and acetylene apparatus. 3. Protective devices for motors and power transmitters, devices for turning on power and shutting it off, belt connection, couplings, etc. 4. Fire protection and the prevention of explosives. 5. First aid to the injured. 6. Mining and quarrying devices in use on stone crushing machinery, etc. Storing of explosives. 7. Metal industry: Safety devices for metal-working machinery. 8. Textile industry; safety devices for looms, carding, etc. 9. Leather and paper industry: safety devices for paper cutting, stamping and moulding machinery. 10. Safety appliances for elevators and hoisting apparatus models. 11. Food products: safety appliances for kneading machines, rollers and cutters. 12. Personal equipment of workingmen: protective spectacles, respirators, suits, etc. 13. Workingmen's dwellings. 14 and 15. Housing: moleds, plans, photographs. 16. Ventilation. 17. Models, photographs and plans of toilets, dressing and living rooms, baths, etc. 18. Cooking: demonstration in heating food; models, plans, photographs. 19. Other social betterment institutions; reports of labor departments, industrial arbitration courts. 20. Agricultural machinery: safety appliances on same, demonstrated by models and views. 21. Lumber industry: safety devices for band and circular saws, planing machinery, etc., demonstrated by models. 22. Models, phographs and plans of workingmen's industrial betterment institutions of all kinds.

Requests for information regarding space should be made to Dr. William H. Tolman, director, 287 Fourth avenue, New York.

ELECTRICITY IN THE ROLLING MILL.

Blooming mills required a prime mover to be self-starting and reversing and all types demand enormous overload capacity. Electric motors receiving current from generators direct-connected to gas engines appear to have, in combination, possibilities which are far beyond anything achieved by the older methods of engine drive. Electric motors are now used to drive "three high" rolling mills with entire satisfaction, compound-wound motors being perfectly adapted to the widely varying character of the load and the requirement for roughly uniform speed between the violent momentary overloads.

Recognizing the advantages of electrical drive in the rolling mill, the various constituent companies of the United States Steel Corporation and the large independent mills of the country are making extensive use of this system.

In order to observe its practical application, let us take, for example, a single motor—one of 180 horsepower, 230 volts, 88 revolutions per minute—furnished by Allis-Chalmers Co., of Milwaukee, for the Youngstown, O., plant of the Carnegie Steel Co., and installed complete, with yoke, shaft, pedestals and armature, for raising and lowering the tables of a blooming mill. The gear reduction for this machine will be about 6.5 to one, based on a speed of 100 revolutions per minute of the motor shaft, and the motor will be required for continuous operation at full load for 24 hours without rising in temperature, in any part, more than 45°C. above the surrounding atmosphere, and without sparking at the brushes.

The machine will be used to raise and lower both front and rear tables of a three high blooming mill table, making 15 operations (7½ complete cycles) per minute. No binding wires will be used on the body of the armature. The shaft will be made replaceable without disturbing commutator or winding, and extended on the commutator end for a magnetic brake.

Ten years ago it is doubtful if the most sanguine friends of electrical drive in rolling mills would have predicted that in so short a time the adoption of electric power for driving heavy rolling mills would become common.

The line of improvement in electrical machinery, which has probably done most to encourage its adoption in mill operation, has been that of developing a high torque at starting. Electricity has thus far found no limit in iron and steel works operations. It has conquered in one direction after another. Its most recent success in driving the heaviest machinery leaves no field unassailed. It is the universal power which helps to raise the iron ore from the ground, separates it, when necessary, by another form of its power, from the gangue, drives machinery in various processes through the conversion into finished product, furnishes light at all stages, and even by magnetic attraction lifts huge pieces of steel when they must be carried from one point to another.

COAL ANALYSIS.

By CHARLES COCHRAN, University of Colorado, '06

The analysis of coal is of interest for two reasons—first, because but little work has been done along the line of analyzing the coals of the State; and, second, because of the great values of the coals to be found in Colorado and the great range of varieties. Incidentally, it is hoped that a better method of analyzing by burning may be found which may be applied to our lignite coals.

The present method of testing consists briefly of pulverizing a sample of coal and by a quartering process of selection a small portion is taken as representative of the whole. This small sample is placed in a proper crucible and slightly sealed to prevent ingress of oxygen from the air, though not preventing the escape of the volatile hydro-carbons. After the crucible and contents have been weighed and sealed, the crucible is set in a muffle furnace, which has been previously heated. In the beginning it is placed near the mouth of the furnace and allowed to remain for three to five minutes. Then it is set back into the hotter part of the furnace for one to three minutes, and is then removed from the furnace, and, still sealed, is allowed to cool. It is again weighed and the weight of the gases driven off is thus determined. This is generally reduced to a percentage of the total weight of the small sample originally taken. After weighing, the crucible is again returned to the furnace, this time uncovered and allowed to remain until the coal is reduced to ashes. Frequent removals from the furnace will accelerate the burning process. When entirely reduced to ashes, the contents of the crucible are again weighed and the proper calculations give the percentages of fixed carbon and ash contained in the sample.

The difficulty with this method, as applied to lignite coals, is that during the volatization process, the gases are driven off so rapidly after the process begins that particles of fixed carbon are carried away with the gases, which tends to cause a showing of a higher percentage of hydro-carbons and a less percentage of fixed carbon than the sample actually contains. If the sample before being placed in the muffle furnace is placed in a dryer and the moisture expelled, the trouble mentioned is greatly lessened, and the amount of moisture may at the same time be determined.

Thus far, the analysis shows the moisture, hydro-carbons, fixed carbon and ash by percentages as they appear in the coal. Next the calorific value of the coal is determined. Again a small sample, this time one-half a gram is taken and carefully dried. This is placed with a chemical high in oxygen in a bomb which is screwed together so as to be air tight. This bomb is then immersed in two litres of distilled water, about 3 degrees F lower in temperature than the room, the water being contained in a carefully constructed calorimeter so that no heat may be taken on from or given off to the outside air. The bomb is then rotated until the temperature of the water becomes constant, when the charge of coal and chemical is fired by means of an electric spark. The rise in temperature of the surrounding water due to the burning of the coal is noted on a thermometer reading to tenths of a degree Fahr. Corrections are made and the B. T. U. required to raise the water through the temperature noted are calculated and this gives the calorific value of the coal.

The ashes found in the bomb are now treated with hydrochloric acid and barium chloride, and the sulphur is precipitated. The solution is then tested photometrically, and by use of a table the amount of sulphur is determined.

Up to the present time the coals tested have been samples which have been in the laboratory for some time. Such tests can hardly be considered a test of a commercial coal, because any sample in a pulverized condition will take on or give off moisture, depending upon its comparative degree of moistness to that of the air of the laboratory. However, these tests are very good as comparative tests between the coals used under the conditions of the laboratory, and will tend to show the relative values of these same coals after a year's storage. These tests will also be valuable to compare with tests made from the same coals in a commercial state.

The annexed table gives the values of various coals as they have so far been determined. The sulphur being determined separately does not become a part of the total percentage in the first analysis, but must simply be read as a percentage by itself. Where the sulphur and calorific values are not given, they have for various reasons not yet been determined.

The writer's acknowledgments for advice and assistance are due to H. E. Murdock, Mechanical Engineering, 1906.

NAME OF COAL.	PERCENTAGES					Color of Ash	Calorific Value in B. T. U.
	Moisture	Hydro Carbons	Fixed Carbon	Ash	Sulphur		
Baldwin	7.80	30.39	58.62	3.19		Brown	12581
Crested Butte	.52	2.16	89.32	8.00		Red	14688
Rex	17.64	26.98	50.68	4.70	1.50	Brown	11760
Black Diamond	7.12	39.84	50.75	2.29		Brown	11821
Rugby	2.32	32.68	54.60	10.40		Grey	12477
Anthracite	4.30	3.25	87.61	4.84		Red	
Crested Butte (cok'g)	.76	33.14	62.22	3.88		Red	
Hezron	1.42	34.95	55.75	7.88	1.00	White	13255
Chandler	5.34	31.35	53.48	9.83	trace	Salmon	11953
Nonac	4.86	33.91	55.30	5.93	1.07	Drab	12383

THE QUESTION OF COMMISSIONS.

In a recent address to the graduating class of Lehigh University, Dr. R. W. Raymond made the following suggestive remarks on an important matter:

"Perhaps the commonest question of casuistry occurring in modern business is that of commissions. As the agent of your employers you have to purchase a steam engine. After getting the prices and inspecting the engines of all the manufacturers you decide upon the machine most suitable, on the whole, for your purpose, and in all legitimate ways beat down the sellers thereof to their lowest price. Just as you are about to close the bargain at the price, they say: 'This covers, of course, your commission of 10 per cent.' When you reply that you do not expect any commission and suggest that, instead of paying it to you, they take it from the amount of the bill they send to your employers, they tell you that according to some trade agreement they cannot charge a lower price, but can pay a commission to the selling agent. Now, you are not the selling agent, but the purchasing agent, and, explaining this difference to them, you tell them that you will be in honor obliged to pay your employers whatever commission may be paid you. To this they reply, with a kindly but cynical smile, that they do not care what you do with the money after you have got it, and you see clearly that they regard your protestations of honor as part of the formula which precedes your acceptance of the money. They do not really believe that you will not keep it if you get it.

"I am repeating an episode of my own experience, and perhaps my solution may be of use to you. I declined the commission offered in currency; required it to be put in the form of a check to my order; indorsed that check to the order of my employers and presented it to them, leaving them, if they saw fit, to return it to me as a legitimate perquisite of my position. They did not see fit, and they were quite right. But the most important feature in my action was that the return of the check, thus indorsed by me in their favor, convinced the manufacturers of my honesty as no amount of high-toned oratory on my part could have done."

Mr. R. G. Hunt, formerly manager and engineer of the San Diego Consolidated Gas and Electric Company, has joined the engineering staff of H. M. Byllesby & Company, and will be located at their Chicago office.

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EDITORIAL.

THE QUESTION OF FRANCHISES

The control of franchises granted to public utility corporations, such as water, gas, electric light and power, telephone and street railway companies, has rapidly become one of the most important problems to be considered in American cities. While in general a franchise was originally understood to give the city merely general supervision of the construction of the system and nominal control of the operation of such companies, the situation at the present time is that in many cases a franchise carries with it exclusive control by, and in reality a monopoly for, the particular company owning such a franchise. Largely due to this fact, franchises have become extremely valuable and are too often used as assets of great importance in connection with the financial side of corporation manipulation.

Yet in order that a franchise shall be of any value whatsoever to a prospective company entering into the field of supplying the public with water, gas, electricity, telephone service or transportation, it must cover such a period of time as will justify the corporation in expending the large sums of money necessary to install such systems. Nothing can be more uncertain than the character of the government of American cities. A decade may bring about such changes in administration that the longer the period of the franchise the better are the people protected, providing, of course, the terms between the city and the corporation in the beginning are such that the rights of the citizens are not entirely neglected.

Any franchise which runs from a period of from 25 to 50 years may be of little value in the beginning but of enormous importance to the city as well as the corporation as the city develops. It would be absurd, for instance, to expect a transportation company to purchase a franchise in a city of 100,000 people and pay for such privilege a sum which would represent the value of such franchise twenty years in the future, or when the city may have a population of from 300,000 to 500,000 people, yet American cities have, in a great many instances, shown such growth in a period of time much less than the life of many corporation franchises. The purchase of a franchise may be compared to the purchase of real estate. Circumstances which cannot be foreseen may interfere with the growth of the city so that the value of the real estate or franchise does not materially increase as time goes on. In such cases, of course, the property or the franchise does not change in value from the beginning to the end of the period under consideration.

The ideal situation would be for each public service corporation to pay annually into the city treasury a sum commensurate with the money value of its franchises or privileges for each year during the life of the franchises. With this object in view many grants are given to companies with the requirement that there be paid to the city a certain per cent of the gross or net earnings. Two difficulties exist in such an arrangement: first, the inability of the city to get accurate information regarding the real earnings of the companies, and second, the necessity on the part of the companies of constantly adding to their investments in order to extend their systems into new territory, which extensions in the beginning at least do not materially increase the earnings.

By the very nature of things certain franchises must grant to the company a practical monopoly. For instance, if there were no limit to the number of street railway companies operating in a city, the necessity of each company's tracks covering the entire populated districts would probably mean that to a great extent the city streets would be given over almost entirely to the street railway companies, thereby reducing the use of the streets for private individuals. A number of water companies, on the other hand, would require an equal number of distribution systems. A duplication of electric light and power companies would result in many underground systems, and in the outlying districts, where overhead construction is allowed, the excessive number of poles would certainly be a great disadvantage. A telephone company by the character of its business is peculiar in this regard, as each subscriber desires connection with the greatest number of other subscribers from his own telephone, and more than one company in a city, while undoubtedly an advantage in one respect, is a decided disadvantage because of the necessity of the duplication of instruments for each subscriber.

Except in the largest cities, the value of a franchise for a brief period is necessarily uncertain. No harm can result in granting a franchise for a long period of time, provided definite restrictions are made to safeguard the city if the franchise should greatly increase in value during the later portion of its life. In other words, if possible, a franchise is something which

should be rented from the city and not purchased, although every corporation for its own protection must control its franchise for a definite period of time. The amount of this annual rental, if it may so be termed, which a corporation should pay to the city is not easily determined. The income of a company may be large and increasing with the growth of the city because its franchise makes it in effect a monopoly or because the company is progressive and is constantly extending its system, thereby increasing the amount of money invested. When payment for a franchise is made by taking a certain per cent of the gross or net earnings the result is not always as it should be, since it is impossible to definitely determine whether an increase of income is due to the value of the franchise or to added investments on the part of the corporation.

The growth of every city depends very largely upon the character of its public utility corporations. While the city should always grant such companies reasonable privileges, yet it is to be hoped that some method may soon be developed which will guarantee to the city, as well as to the corporations, such protection and security as will give a just recompense to each, no matter what changed conditions may come about during the life of the franchises or other exclusive privileges.

TRADE CATALOGUES.

The latest issue of "Graphite," the monthly publication issued by the Joseph Dixon Crucible Co. of Jersey City, N. J., in the interest of their graphite productions, contains among other items of value to all interested in graphite productions, the result of an exhaustive test by Prof. W. F. M. Goss of Purdue University, to determine the comparative lubricating values of amorphous and flake graphite.

These tests show according to the report that foliated or flake graphites are superior to the choicest amorphous graphite as a lubricant.

The Central Electric Co. of Chicago enjoys a distinction amongst supply houses of having a room fitted up and devoted exclusively to the display of fixtures. It is located on the first floor of their new building at 264-270 Fifth avenue, in connection with their retail department, and all the latest styles and finishes of electric and combination fixtures are to be found therein. No more complete line of portables and table lamps is shown anywhere, and anyone interested is cordially invited to visit the Central Electric Co. when in Chicago.

"Sunbeams" is the title of a unique booklet of catchy verses, which is being distributed by the California Electrical Works, of San Francisco, the California Electric Company, of Los Angeles, and the Western Electric Company, of Seattle, Washington.

Originality is one of the distinguishing features of same. The booklet, in addition to the verses, illustrates and incidentally exploits the merits of the well-known Sunbeam lamp. It is attractively gotten up in blue and yellow, and is well worth sending for.

A copy will be sent to any one interested, upon request.

Mr. Samuel C. Shaffner, formerly engineer and general manager of the Illuminating Company of Mobile, Alabama, has joined the engineering staff of H. M. Byllesby & Company, Chicago.

PACIFIC COAST GAS ASSOCIATION.

SPECIAL NOTICE.

To the Members of the Pacific Coast Gas Association:

Gentlemen—The fourteenth annual convention of the Pacific Coast Gas Association will be held in the assembly hall of the association, 925 Franklin street, corner of Ellis street, San Francisco, Cal.

MONDAY, SEPTEMBER 17, 1906.

Annual meeting of directors at 8 p. m., room 21, 925 Franklin street. All members are invited to attend session of board.

TUESDAY AND WEDNESDAY, SEPTEMBER 18-19.

Sessions will be held from 10 a. m. to 12:30 p. m., and from 1:30 to 5:30 p. m. of each day.

WEDNESDAY, SEPTEMBER 19, 1906.

At 6:45 p. m., the usual banquet at Tait's Cafe, corner Van Ness avenue and Eddy street.

THURSDAY, SEPTEMBER 20, 1906.

Annual excursion and luncheon to members, their families and friends.

Headquarters for members, room 21, 925 Franklin street. The following papers will be presented:

PRESIDENT'S ADDRESS.

1. "Should Gas Companies Engage in the Sale of Gas Appliances?" .....W. B. Cline
2. "Best Methods of Promoting Gas Sales"..S. P. Hamilton
3. "How the San Francisco Gas & Electric Company Supplied 40,000 Consumers After the Fire".E. C. Jones
4. "How Electricity was Served to Consumers and Street Car Lines by the San Francisco Gas and Electric Company After the Fire".....L. E. Reynolds
5. "Personal Experience with Municipal Gas Plants".. .....C. E. Moore
6. "The Equity of Sliding Scale Gas Rate"..F. A. Leach, Jr.
7. "Experience with High Pressure Gas Mains"..... .....Sherwood Grover
8. "Utilization of Gas Engines for Power Purposes".. .....E. C. Lufkin
9. Subject to be announced.....James Goodwin
10. Subject to be announced.....E. A. Rix
11. "The Art of Canvassing".....John Clements
12. "The Gas Institute".....F. H. Shelton
13. Novelty Editor . . ..G. H. Hollidge
14. Wrinkle Editor..... .....Geo. S. Colquhoun
15. Experience Editor.....R. P. Valentine
16. Historian .....Geo. P. Low

There will be an unusually interesting display of novelties in gas appliances during the session, special attention being given to exhibition of articles of merit and originality.

Applications for membership will be received until Tuesday, September 18, 1906.

Come one, come all, as the fourteenth annual gathering promises to surpass all others; but to insure this, attendance of members is especially required. Yours very truly,

JOHN A. BRITTON, Secretary.

THE ENGINEER AS A WITNESS BEFORE THE COURTS.*

The engineer entering into the practice of his profession rarely knows the exact field which he will be called upon to occupy or what problems he will be expected to solve. At this time, when electricity enters so largely into engineering, no well-equipped engineer can afford to be unfamiliar with its foundation principles. No more can he neglect the fundamentals of steam, hydraulic and other fluid motors. The well-equipped engineer will know the principles which underlie dams and waterways; railroads and highways; mines and tunnels; bridges and wharves; steamships and dredges; and all the machinery which makes these possible. The engineer who is well grounded in the principles of engineering will not be taken by surprise with any problem that may be presented, and if he have the genius, he will work out his own salvation.

Most engineers, after they have been in general practice for several years, find it advantageous to specialize. Some unfortunately begin to specialize while they are still at school, and if one happens to select a specialty which later on proves to be in harmony with his genius he may succeed; but unless he studies after he leaves school, what he should have studied while in school, he will never get a broad and strong grasp of his profession.

I believe more good engineering will result from a thorough grounding in fundamental principles, followed by several years of general practice, and that followed by a specialty; but not, however, until the engineer has discovered what he is good for, and what kind of work is most congenial to his special genius.

Engineers are often called as witnesses before the courts to give testimony on all sorts of technical and engineering questions and to stand cross-examinations upon them; but most of them do not like it; but the engineer who is well grounded in his principles, sticks to the truth and them, and keeps his head, need have no fear on the witness stand.

The engineer may be called as a witness in suits growing out of accidents to persons and property, breaches of contract, disputes as to rights of way, water rights, etc., but he is called most frequently in litigation growing out of the infringements of patents for inventions.

A few words in regard to the United States patent system may be of interest at this point:

"Any person, whether he or she be an American citizen or a foreigner, 'who has invented or discovered any new and useful art, machine, manufacture, or composition of matter,' may obtain a patent in the United States under certain rules of the Patent Office.

"An application for a United States patent must be made in writing, addressed to the Commissioner of Patents.

"The invention must be illustrated by drawings when possible. A model may be required, but of late years is seldom demanded by the Patent Office.

"The invention must be fully and clearly described, so as to enable a person, skilled in the art to which the invention belongs, to build it; and the particular things which the inventor claims as his own, must be specifically described in the claims at the end of the specification.

"The inventor must make oath that he believes himself to be the original and first inventor or discoverer of the thing for which he seeks a patent; and that it was not before known or used.

"After the application is filed it is examined by the examiners of the Patent Office to ascertain whether it really discloses an invention, and if it does, whether the applicant is the first inventor.

"If any claim of an application be rejected by the Patent Office the applicant is notified in writing and informed of the reasons for the rejection, and given reference to the prior publications which may have caused the rejection. The applicant may then amend his claims or insist on his original claims. In either case he can have a re-examination by the same examiner or appeal to the 'Board of Examiners-in-Chief,' and then appeal to the Commissioner of Patents in person, and finally to the Court of Appeals of the District of Columbia."

It frequently happens that an application as originally made contains a great number of broad claims, but after it has passed the ordeal of an examination in the Patent Office it comes out with a small number of very narrow or limited claims.

Frequently applications for patents come into "interference" with each other, or even with patents that have already been granted; that is, two or more inventors make application for a patent on the same invention.

The Patent Office may put any two or more applications into "interference," which appear to claim the same invention, and then each applicant must make a sworn statement of the date when he conceived his invention; when he made sketches, drawings or models of it, and when he reduced it to practice. He must also furnish proofs of his statement. The applicant making the best proof of his priority gets the patent and the others are rejected. Appeals may be taken from the decision of the Examiner of Interferences the same as from any other examiner.

In this connection I may state that any person may make application for a patent in person, but he will save himself much time and annoyance by employing a competent patent solicitor. I say "competent" because there are many solicitors who are not, and because it is much easier to get a patent with a large number of long claims limited to exact details than to obtain a few short, broad claims which have some value. The best time to spend money for good talent on a patent is during the time that the application is passing through the Patent Office. Money well spent at that time may save the spending of much more later on, in trying to stop infringers. Many valuable inventions are lost by incompetent solicitors who either fail to grasp the invention or do not describe it properly, or fail to write such claims as will protect the invention. Incompetent solicitors make litigation, litigation creates employment for experts.

Patented articles must be marked with the word "Patented," followed by the date of the patent or else damages cannot be collected from an infringer. Marking things "Patented," when no patent has been issued for them, is illegal.

Every patent is granted to the patentee, his heirs or other assigns, for the term of seventeen years from the date of its issue by the Patent Office. No patent is issued until the final fee is paid, and this fee must be paid within six months after the patent has been passed and allowed, or else it becomes void.

The Government does not guarantee the validity of the patents which it issued through the Patent Office. The validity of a patent may be attacked at any time during its life and it can only be finally established by the Supreme Court of the United States, and even then that Court may review and reverse its decision. It is very unusual, however, for the question of the validity of a patent to reach the Supreme Court; such a question rearely gets beyond the Circuit Court of Appeals of the United States.

The struggle for life of a patent for a valuable invention begins with the application for it in the Patent Office, and ends only when it expires seventeen years after its issue. A patent for a valuable invention is almost sure to be infringed by persons who innocently make, use or sell that invention, or by others who knowingly appropriate the invention and defy the inventor or the owner of the patent. Such illegal manufacture, use or sale of a patented invention, whether unknowingly or intentionally made, may result in a suit for infringement of the patented rights of the owner of the patent.

The several Circuit Courts of the United States have original jurisdiction of all suits arising under the patent laws

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By Jesse M. Smith in "Sibley Journal of Engineering."

of the United States. Suits involving infringement of patents must be brought in the United States Circuit Court for the district where the infringement was committed; and the suit may be brought against the party committing the infringement or against any agent conducting the business of that party in that district. Suits for infringement of patents may be brought either on what is called the "law side" of the court or the "equity side" at the discretion of the owner of the patent, who is the complainant. The infringer is the defendant.

When a suit is brought on the "law side" of the court the testimony is generally taken in open court before a jury. This, however, is quite an unusual proceeding, as the great majority of patent suits are brought on the "equity side" of the court. When an injunction to stop an infringer from making, using or selling a patented invention is desired, either with or without recovery of damages or profits, the suit will be brought on the "equity side" of the court. When no injunction, but only damages are desired, the suit will be brought on the "law side."

In a "patent suit in equity" the court rarely knows or hears anything about the case until all the testimony, and the briefs of the attorneys, in printed form, with the exhibits, are presented at the oral argument of the case in open court. It may be of interest to outline the procedure in preparing a "suit in equity" for submission to the court:

First—A "bill of complaint" is filed with the clerk of the United States Circuit Court in the district where the infringer or his business agent resides. This bill sets out at length that the infringer has greatly damaged the owner of the patent, and charges him with the unlawful use of his patent and prays the court to stop the infringer from making, using or selling his invention, by issuing an "injunction" against the infringer and praying also for an accounting of damages ad profits.

Second—The infringer is served with this "bill of complaint" and he then files with the clerk of the court his "answer." The "answer" sets forth at length the denial that he has infringed the patent, and that, anyway, the patent is invalid for various reasons, of which the five following are the principal ones:

(a) That the patent "contains less than the whole truth relative to the invention, or more than is necessary to produce the desired effect."

(b) That the patent was surreptitiously or unjustly obtained for that which was in fact invented by another who was using reasonable diligence in adapting and perfecting the same.

(c) That the same invention had been previously patented or described in some prior printed publications; or that the invention of this patent had been described in a printed publication more than two years before an application was made for it.

(d) That the inventor was not the original and first inventor or discoverer of any material part of the thing patented.

(e) That the thing patented had been in public use or on sale in this country for more than two years before application was made for a patent; or that the invention had been abandoned to the public.

The "answer" in other words, sets forth in general terms what the infringer expects to prove, and the printed documents and names of witnesses by which proof will be made.

Third—The owner of the patent then files the "replication," which is a general denial of everything in the "answer." The "issue" is then said to be "joined." Then the fight begins; the owner of the patent is the "complainant," and the infringer is the "defendant." Many suits do not get beyond this stage. Some are brought for commercial or advertising purposes and are either compromised or abandoned.

Fourth—After the "issue is joined" the complainant commences the fight by making what is called the prima facie proofs of infringement. This is generally done by calling an expert witness. He gives his testimony generally in the office of the complainant's attorney, or his own office, and in most cases dictates his testimony direct to a typewriter. He is first sworn by the clerk of the court, or a notary or other officer competent to administer oath, to "tell the truth, the whole truth, and nothing but the truth."

The expert is asked as to his qualifications to give expert testimony. He then states his understanding of the structure shown by the drawings and described in the specification of the patent in suit; his statement being all taken down on the typewriter, forms part of the record in the case. The expert then reads into the record, the claims of the patent which are charged to be infringed. He then describes the defendant's structure, generally by the use of a drawing of the structure, or by a model, or by the structure itself, or all of them. All these are offered in evidence and are marked as "exhibits."

The expert then points out, or should point out and identify in the defendant's structure, each element of the mechanical combination which he thinks is described in each claim of the patent, which is sued upon, and he describes it in his testimony. This generally completes the direct examination of the expert. He may or may not be cross-examined by the defendant's attorney. It will, of course, be understood that the complainant's attorney and the expert have conferred together beforehand, and have decided which of the claims of the patent in suit they think they can sustain and successfully charge with infringement; but when it comes to taking the testimony the burden is on the expert.

Suit may be brought on any one or more of the claims of the patent in suit without involving the other claims.

Fifth—The complainant having completed his "prima facie" proofs of infringement, the defendant is given an opportunity to put in his proofs in opposition to the charge. A search has previously been made to discover whether the invention of the patent in suit had been on sale, or had been described in a printed publication, more than two years before the patent was applied for. Also, whether the same invention had been patented to another person, in this or any foreign country, prior to the date of the application for the patent in suit. Also whether the same invention had been described in any prior printed publication either foreign or domestic. Also, whether a structure containing the invention has been made and used by another in this country prior to the date of application. The making and using of such a structure in a foreign country has no effect upon an American patent, unless it can be connected with a printed publication describing that structure.

As illustrating the peculiar working of the law in special cases, the story is told of a suit brought in the Eastern District of Maine for infringement of a patent. The defendant proved beyond a doubt that a machine containing the invention of the patent had been made and used just across the river in the British provinces before the invention of the patent was conceived. The complainant did not dispute the fact, but rested on the law. The court held the patent to be valid. If the machine had been made and used on the American side of the river the patent would have been void, but having been made and used a half mile farther east, the patent was valid.

A search is also made in the files of the Patent Office to learn the history of the application for the patent, and to discover whether the claims had been rejected or amended or canceled before the patent was issued, and the reasons for such actions.

A complete copy of all the documents which bear upon the history of any application for an issued patent can be obtained from the Patent Office by any person who will pay for it. This collection of documents is certified to be a correct copy, by the signature of the Commissioner of Patents under the seal of the Patent Office. It is generally received in evidence without objection by either attorney, and goes by the name of the "File Wrapper and Contents," or "File

Wrapper" for short. The "File Wrapper" will generally give some indications of whether the patent has been obtained by fraud, or tells less than the whole truth, or describes more than is contained in the invention recited in the claims.

It is the function of the expert in patent cases engaged by the defendant, to take the mass of technical information brought out by these searches; to study it carefully in connection with the patent in suit and the defendant's structure, and then in conference with the defendant's attorney, to determine and decide upon the theory of the defense.

The main questions raised by the defense in patent litigation are:

(a) Is the patent valid?

(b) Does the defendant's structure infringe the patent on its face?

(c) Is the patent so limited in its scope by the prior publications and uses (technically called the "Prior Art") as that the defendant's structure escapes infringement? These are questions which the defendant's expert must answer in his testimony. They should be answered clearly, concisely, accurately and truthfully, and be so fortified with good reasons and demonstrations as to be convincing.

Working models are sometimes very valuable for the demonstration of the exact mode of operation of an invention. I recall the first time that I acted as expert in a patent case. It related to the up-drop sight feed lubricator for steam engine cylinders, which is now so common. The principle involved was the displacement of the oil held in the oil chamber by water resulting from the condensation of steam in a pipe leading from the steam pipe of the engine into the side of the oil chamber. It was supposed that the water would enter the oil chamber drop by drop and drive the oil out drop by drop, and as it left the chamber it would rise through a glass tube filled with water and thus be visible as it rose drop by drop and passed on to the steam pipe of the engine.

I had a model made exactly like the drawing of the patent and connected it to the steam pipe of an engine exactly as described in the patent. The sight feed worked just as it should have done and just as was expected; but I discovered that there was another feed, backward up through the little steam pipe that supplied the water. Then I put a glass section in this little pipe, and I had a double sight feed, one operating in the right direction and the other backward. The engine was getting twice as much oil as the regular sight-feed indicated. The little steam pipe entered the side of the oil chamber near the top. The hole in the pipe was large enough to let water pass downward and oil upward through the same pipe at the same time.

In the defendant's lubricator the little water pipe entered the oil chamber near the bottom and below the water level in the chamber, so that the oil could never reach the little pipe and could not feed backwards. The expert for the complainant was obliged to admit that the defendant's lubricator did not depend for its operation upon the size of a hole, while the lubricator of the patent did.

The result was that the case stopped right there, and the defendant was given a license to pursue his very lucrative business in the West, while the complainant was confined to the East.

Sixth.—The defendant having finished his "Proofs in Defense," the complainant comes in with his "Proofs in Rebuttal," as they are called. At this stage of the case the complainant's expert finds his opportunity; he has the last word. He must uphold his position taken in his prima-facie testimony, and combat the position taken by the defendant's expert. He must search out the weak points in the reasoning and demonstrations of the defendant's expert, and try to overcome them by counter-reasons and demonstrations. If he is to succeed he must, while resting on his first position as a base, advance such convincing reasons and proofs as will overcome the position of the defendant's expert. If he abandons his first position (as he is sometimes obliged to do), it may give the other side an opportunity to take more testimony, or come in with "Proofs in Sur-Rebuttal," as they are called.

The defendant's expert then has another opportunity to strengthen his position; but he must do it with great care, because the complainant's expert still has the last word. The testimony now being all taken by both sides, the experts have finished their work. The expert is, however, sometimes called into conference with the attorney for his side, to consider the whole situation before preparing the case for argument before the Court.

Before submitting the case to the court, all the testimony is printed, and the attorney for each side prepares his "Brief." The "Brief" is supposed to contain a concise statement of the main points of the testimony, and of the main points of the argument, which the attorney expects to present to the court. Frequently a "Brief" is a volume much larger than the name would indicate.

The "Brief" of each side is also printed before the argument, and the attorneys exchange "Briefs" a few days before they are to appear in court. At the argument before the court the attorney for the complainant opens, by presenting the facts, explaining the "Exhibits" and showing to the court the defendant's structure, and in what way he thinks it infringes the patent in suit. The attorney for the defense then presents his proofs and arguments in defense of the charge of infringement, and then the attorney for the complainant replies, and he has the last word.

Working models are often very convincing to the court at the argument of a patent case, but they seem at times to be endowed with a perversity that it almost muleish. At the argument of a case (also relating to sight-feed lubricators), a very noted and able attorney wished to operate in court an old lubricator which he had found in operation on an old engine, and which clearly anticipated the patent in suit. In order to be sure that the apparatus was all right and would work as he had often seen it, he had tested it himself the day before, and brought it into court with great confidence. It had never failed to work as it should.

At the hearing before the court he led up to the climax with great skill, and then tried to start the lubricator. It absolutely refused to work. The attorney grew red, but assured the court it would start presently. The attorney on the other side, wishing to add a word to his brother's discomfiture, rose to address the court. The judge motioned to him to sit down, saying, "That little machine is making a better argument than you possibly can." When the lubricator was tried next day it worked all right. It transpired that the over-zealous client, without the knowledge of his attorney, had used hot water instead of cold.

The argument of a patent suit before the court usually occupies at least one day, and may require two, three or more days.

When it is considered that the record in a patent suit consumes months, and not infrequently years, in its preparation, it will be realized that the attorneys have a great load of responsibility to carry, and besides the thought and hard work in preparing for the argument, they have a most strenuous time at the argument. The judges of the court also have their minds burdened to the utmost to grasp the subtle theories and delicate shades of difference which are presented to them by the attorneys during the few hours of the argument; and from which, with the records in the case, they must decide the points in controversy.

The wonder is, that the judges, who have usually had no special training in science or engineering, can grasp and decide aright the often very intricate questions involved in patent cases. The fact is, that these questions are decided aright in the great majority of cases.

It is true that most patent cases are carried up to the United States Circuit of Appeals, but often only with the hope that the higher court may look at some of the questions differently, and decide them differently. The Circuit Court

of Appeals, which is composed of three United States judges, is the highest court to which a patent suit can be carried, except when two courts of Appeal in different circuits decide differently regarding the same patent in suit. Then, upon the application of any party in interest the United States Supreme Court may order both cases before it for final adjudication.

The question is frequently asked, how can a reputable engineer act as an expert on that side of a patent suit which he believes to be in the wrong? My answer is, he can not. If he feels sure in his own mind that the party who seeks to engage him is wrong, then he can not act. It must be borne in mind, however, that most patent suits are either brought or defended by reputable attorneys, and they will not risk their clients' interests or their own reputations in litigation in which they have no hope of success.

It not infrequently happens, that an expert is asked to take a position, or support a theory, in which he does not believe. In that case the only thing for him to do is to decline to give testimony, even though he has been retained in the case. No reputable expert can afford, or will allow himself to be put, in a false position. If he gets into such a position it will generally be because he did not have a clear understanding with the attorney on his side, before going on the witness stand, or because he has been careless in his statements on direct examination. In either case, as soon as he discovers himself to be in a false position, he should frankly admit it and set himself right.

It should always be borne in mind that cross-examination follows the direct-examination. It is not safe to assume that our side knows more about the case than the other side. It is dangerous for an expert to give testimony in a case that he has not studied sufficiently to understand—he will probably come to grief on the cross-examination.

The expert who has thoroughly studied and understands his case; who has been careful, exact and truthful in giving his direct testimony, and who keeps cool, need have no trouble on cross-examination. Frequently such an expert is not cross-examined at all by an experienced attorney; but some attorneys, younger in experience, feel it incumbent upon them, in the supposed interest of their clients, to cross-examine at length. They sometimes discover, when they come to read the testimony in cold print, that it would have been better for their case had they stopped the cross-examination earlier.

Generally speaking, there is no such thing as the "right" side or the "wrong" side in a patent suit. Sometimes suits are brought unjustly for the purpose of annoying and embarrassing a competitor in business; and, on the other hand, suits are sometimes defended unjustly because the infringer wishes to embarrass the owner of the patent, and would rather risk the expenses of litigation than pay a larger sum for the right to use the invention. Fortunately, such suits are not frequent, and are often brought for the purpose of compromise. They are of no interest to the expert in patent cases.

The technical "right" or "wrong" in patent suit rests upon the opinion of one judge in the first instance; upon the opinion of the majority of three judges in the second instance; and, finally, upon the opinion of a majority of the judges of the United States Supreme Court. This last opinion is final, whether it be "right" or "wrong."

Frequently a patent is held by the court to be valid; but that the defendant's structure does not infringe it. Frequently certain claims of a patent are held to be valid and infringed; while other claims of the same patent are held to be valid but not infringed; while still other claims are held to be invalid. In such a case "right" and "wrong" is distributed between the contestants. The theories and demonstrations of the expert on one side may be just as true and convincing as those of the expert on the other side, and the decision of the case may turn on the mere wording of a claim or the meaning of a single word.

In most patent suits there is ample scope for the knowledge and ingenuity of the expert on each side, while still permitting each to remain well to the right of the line which separates truth and honesty from trickery and dishonesty. In patent litigation, as everywhere else, "Honesty is the best policy."

What education and practice should an engineer have to best fit him to become an expert in patent cases? My answer is: First of all, a most thorough grounding in scientific principles; after that, a general practice covering as wide a field of engineering as possible. I believe an expert in patent cases should be an engineer first, and then only take up the work of an expert, as a specialty of engineering, after he has sufficient engineering experience to properly qualify him to do so.

The engineering profession should always be practiced with honesty and vigor and upon the highest plane, but never more so than when the engineering profession meets the legal profession before the Courts of Equity.

WESTERN POWER COMPANY.

It is announced that the syndicate managers who own or control, through stock ownership or otherwise, the Western Power Company of New Jersey and its affiliated enterprises are F. H. Ray of the American Tobacco Company, A. C. Bedford of the Standard Oil Company, J. W. Wallace, president of the Central Trust Company; Edwin Hawley and Philip Stockton.

The Western Power Company was incorporated in New Jersey on August 21 with $18,000,000 authorized capital stock, in accordance with an underwriting agreement dated June 6, 1906, for financing the Feather River water power project in California. The syndicate managers own, control or have options to buy the Eureka Power Company, the Golden State Power Company and the Western Power Company of California.

They have devised the plan of forming a corporation under the laws of California, under the title of the Feather River Power Company or other appropriate name. All the capital stock, the authorized issue to be $25,000,000, except directors' qualifying shares, are to be vested in the New Jersey company, the ownership of all properties of the Eureka, Golden State and Western Power companies will be vested in the same concern.

The capitalization of the Western Power Company of New Jersey consists of $6,000,000 in preferred shares, entitled in preference to the common to par on distribution of assets and to dividends at the rate of 6 per cent, to be accumulative after January 1, 1912. The common stock issue is to be $12,000,000.

The $25,000,000 bond issue of the proposed California company is secured by a first mortgage lien on the properties of the three power companies named. The bonds will be 5 per cent. Of this amount $16,700,000 will be issued for additional properties, betterments and improvements, and $8,300,000 for the payment of all expenses on account of the Feather River Water Power project, any balance to be used by the company for dams, electric plants, transmission lines and other improvements.

The agreement provides for the purchase of not more than $7,000,000 and not less than $4,000,000 of the bonds, and not more than $3,500,000 and not less than $2,000,000 of the preferred stock, the price to be paid by the subscribers being $900 and accrued interest, if any, for each $1,000 bond, together with $500 preferred stock.

Point Richmond, Cal.—The Oakland Gaslight & Heat Company has completed its main from Oakland to this city. The Richmond Light & Power Company has contracted to purchase the gas from the Oakland company and in turn will sell it to its patrons here.

INDUSTRIAL.

NATIONAL AIR COMPRESSORS.

The National Brake & Electric Co. of Milwaukee announce in their Bulletin No. 370 the purchase of the plant and other assets of the National Electric Co. and its predecessors, the Christensen Engineering Co. In this connection they have acquired a well-equipped factory with all the neces-

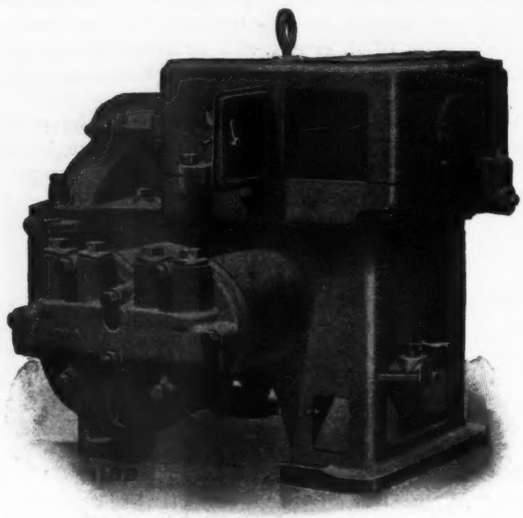

FIG. 1.—NATIONAL COMPRESSOR.

sary tools and a well organized force of men, thoroughly experienced in the manufacture of air brake apparatus. A number of new improvements have been incorporated to conform to present demands for an up-to-date motor-driven air brake, and they are now being placed on the market.

Fig. 1 shows the new type A-4 motor-compressor assembled. This type differs from other makes of compressors which have the motor on top of the crank chamber, in that

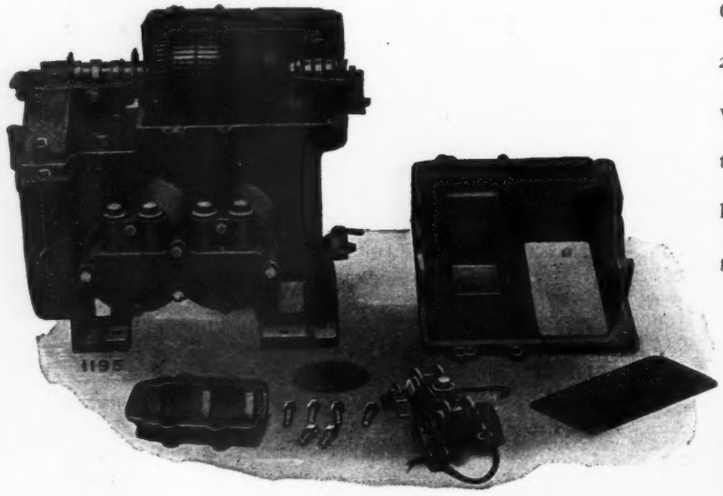

FIG. 2.—SHOWING SIMPLICITY AND ACCESSIBILITY.

the motor and compressor are both separate, self-contained and distinct units, although when assembled the complete compressor is very rigid and compact.

Figs. 2, 3 and 4 show the various elements of the compressor and give an idea of its simplicity and accessibility.

The standard type is as shown in Fig. 1, and designs have been made for six sizes, of the following capacities in cubic feet of free air per minute: 11, 16, 20, 27, 35 and 50.

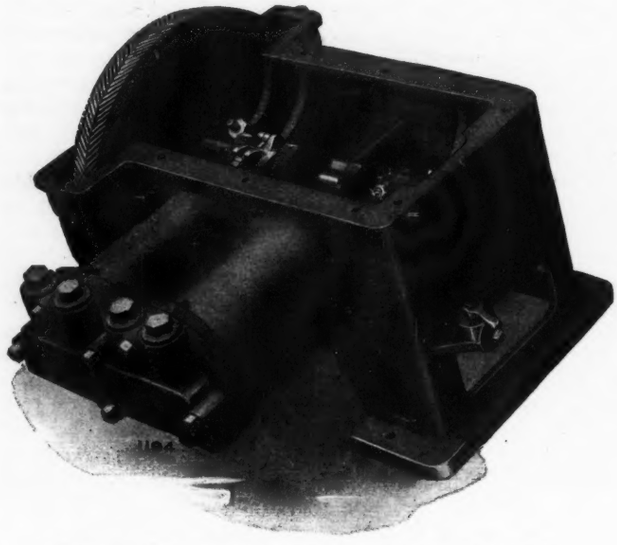

FIG. 3.—CRANK CHAMBER WITH COVER REMOVED.

it is manufactured for standard direct current voltages of 500, 550 and 600 volts and for single phase 25 cycle circuits of 200, 250 and 300 volts, the latter alternating current motors being suitable for running on either alternating or direct current.

NATIONAL BRAKE AND ELECTRIC CO. SALES.

Among recent orders for electrical machinery, the National Brake & Electric Co., of Milwaukee, reports the following:

George W. Pitkin & Co., Chicago, Ill., one 100 kilowatt engine type alt.

Clinton Sugar Refining Co., Clinton, Iowa, one 400 kilowatt and one 75 kilowatt engine type alt.

Alliance Electric Light & Power Co., Alliance, Neb., one 100 kilowatt belted type alt.

Fort Morgan Electric Light & Power Co., Fort Morgan, Colo., one 75 kilowatt engine type alt.

Stillwater Gas & Electric Co., Stillwater, Minn., one 250 kilowatt engine type alt.

Clymer Power Co., Riegelsville, Pa., one 500 kilowatt water wheel alt.

Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo., two 150 kilowatt water wheel alt.

Rockford Malleable Iron Works, Rockford, Ill., one 200 kilowatt engine type DC gen.

Romadka Bros., Milwaukee, Wis., one 150 kilowatt engine type DC gen.

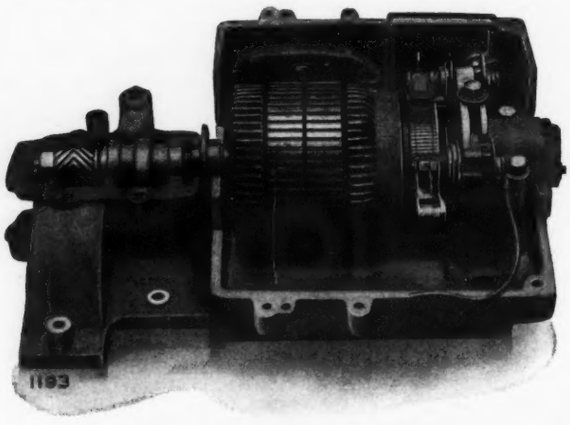

FIG. 4.—LOWER HALF OF MOTOR.

THE H. W. JOHNS-MANVILLE FIRE.

A small fire occurred at the Brooklyn plant of the H. W. Johns-Manville Co. on the evening of August 30th. In spite of some exaggerated accounts which appeared in the New York newspapers, the damage was comparatively small, and the fire has not in any way interfered with the business of the company, as the department affected was in operation by noon of the following day.

L. B. ALLEN COMPANY, CHICAGO.

We are in receipt of the following letter from one who has tried our material:

"I beg to acknowledge receipt of the sample of Allen Liquid Flux sent me on the 24th of July. I have tried the liquid on several large commutators, and like it better than anything I have ever used. I have asked the company to place an order with you. Allen Liquid Flux or nothing for commutators."

LONG CROSSHEAD BLOWING ENGINE.

A few months ago the Thomas Furnace Co., of Milwaukee, one of the largest producers of pig iron in Wisconsin, purchased from Allis-Chalmers Co. a Long crosshead blowing engine of the latter's standard type, a great many of which are in use throughout the United States.

This engine has been installed to operate under somewhat unusual conditions. The plant originally consisted of two 42-inch and 84x54-inch Long crosshead blowing engines fitted with piston valves and throttling governor. The engines were very expensive in their operation, so much so that a large quantity of coal was burned in addition to the gases taken from the furnace to make the steam required to operate them. The new engine receives its steam from the exhaust of one of the old ones, the other being shut down.

The exhaust steam from the new engine is condensed with a barometric condenser. This condenser is provided with double tail pipes and a novel form of air injector nozzles, which effectually removes the air from the condenser without the use of a dry air pump. The water is supplied to the condenser by a 10-inch centrifugal pump driven by small vertical engine. This pump and engine are the only parts of the condensing system that require any attention whatever. The water for the condenser is taken from the Kinnickinnic river, a very foul stream, and its temperature is about 82 degrees. With this warm injection water they are able to easily maintain 26-inch vacuum. Since the new engine and its condenser has been put in operation about 40 per cent of the boilers have been taken out of commission. The waste gases from the furnace make all the steam required, thereby eliminating the coal which was formerly required to provide steam for the old plant.

The plant has now been in successful operation for some time and it is a good example of what can be done to improve the economy of an existing plant.

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The new blowing engine, concerning which in itself many interesting details might be given, has a steam cylinder 84 inches in diameter, air cylinder 84 inches in diameter and stroke 60 inches. The steam cylinder is provided with the well-known type of Reynolds Corliss valve gear. The governor is actuated direct from the lay shaft which operates the steam and air valve gear. It is fitted with a device for varying the speed and capacity of the engine. A hand cut-off is also provided, which is so arranged in connection with the governor that either can be used independently of the other. When the hand cut-off is in use the governor acts as a safety stop to prevent excessive speed of the engine. There are two inlet and two discharge valves in each air cylinder head. The inlet valves are of the balanced piston type and

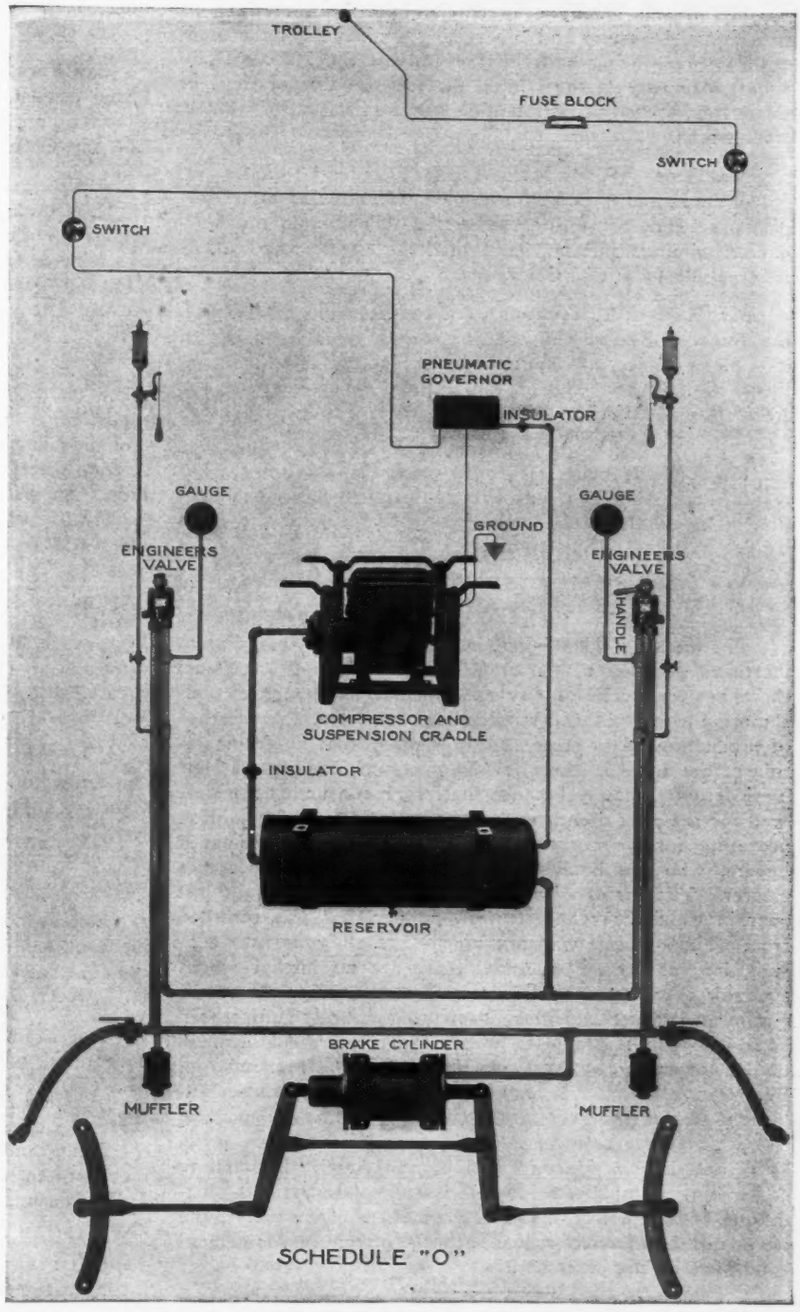

FIG. 5.—DIAGRAM OF THE NATIONAL STRAIGHT AIR BRAKE EQUIPMENT.

positive in their operation. The discharge valves are of the cone drawn cup shape type, which open automatically at any point of the stroke, whenever the air pressure in the cylinder equals that of the receiver, and are mechanically closed when the air piston reaches the end of its stroke. They are held in that position by the pressure of the air in the receiver. This type of valves for air cylinders has been thoroughly demonstrated by long periods of use to be absolutely reliable and highly efficient.

PERSONAL.

Mr. O. A. Farrar, formerly engineer of Allis-Chalmers Co., has joined the engineering staff of H. M. Byllesby & Co. and has charge of the reconstruction work of the large modern electric lighting plant which H. M. Byllesby & Co. are constructing at Mobile, Ala.

Messrs. H. M. Byllesby & Co. have been retained as consulting, designing and supervising engineers for the modern gas plant being built by the Indiana Steel Co. (a subsidiary company of the United States Steel Corporation) at Cary, Ind., the city it is founding for the location of its new steel works.

Mr. George F. Maddock, formerly general superintendent of A. L. Ide & Sons, Springfield, Ill., and for some time past practicing consulting engineer with offices in the Marquette building, Chicago, has joined the engineering staff of H. M. Byllesby & Co., Chicago.

Mr. Howard T. Troutman, for ten years connected with the Buckeye Engine Co. and for several years manager of its Chicago office, has resigned to accept the sales management, Corliss and high speed engine department of the Atlas Engine Works, Indianapolis. Mr. Troutman's headquarters will be at the home office.

Mr. J. M. Broucher of the Brownell Co., Dayton, O., has resigned his connection with that company to accept the position of assistant general managership of sales for the Atlas Engine Works of Indianapolis.

COPPER AND LEAD.

The metal markets have continued strong of late, despite increased production. In copper, the position is excellent; there are no stocks of any consequence in existence; consumption continues at a tremendous rate, and the increase of production is not more than normal, so that no accumulation of the metal is likely for the present. Business at New York is quiet, mainly because the larger consumers are covered for the next month or two, and the depressed condition prevailing for the moment in the stock market has influenced buyers, who are holding aloof until the horizon becomes clearer. The threat of a return of the copper bought last year in China has vanished; the copper that was returned from China—and it was not much—has all gone into consumption; as far as we know there are no further stocks available there that could be re-sold in the American or the European markets. Unless something wholly unforeseen should happen, it is safe to predict that the present firmness of the copper market will continue during the remainder of this year, at least. In lead also the market continues unusually strong, the present production and stocks appearing to be inadequate to meet the enormous demand. The price, as is well known, is controlled by the American Smelting & Refining Company, so that it is subject to artificial conditions, but the policy of this corporation is conservative, and we do not look for any reduction in the price, because general conditions do not warrant it.

Vancouver, B. C.—Definite announcement is made that the Grand Trunk Pacific will build to this place.

News Notes.

FINANCIAL.

Bisbee, Arizona.—At a meeting of the city council, communication was received from the American Light and Water Company of Kansas City, stating that the company would take the whole issue of municipal bonds, paying par for them, if, on their part, the city council would award the company the contract for the construction of the sewer. The city attorney states that bonds cannot be sold this way, and the local banks will present bids for the amounts they have agreed to take, and that at the next council meeting the bids will be opened and the bonds awarded.

Santa Barbara, Cal.—The Merchants' Mutual Light and Power Company, in order to increase its facilities, will issue bonds in the sum of $75,000, to provide means for these improvements.

San Francisco, Cal.—An assessment of $10 per share was levied August 25th on the capital stock of the Wutchumma Water Company, payable in Visalia, delinquent October 15th, sale day October 29th.

Los Angeles, Cal.—The injunction suit brought by Gen. H. H. Sherman against the City Council preventing it from selling the $300,000 bonds voted by the citizens two years ago with which to establish a system of water works for the city, will come up in Cincinnati about September 15th. City Attorney Roy Goodrich is preparing the city's side of the case.

Monrovia, Cal.—The session of the Board of Trade was taken up with the report of Chief Engineer O. K. Parker's report regarding the improvement of Monrovia's water system, advising the expenditure of from $80,000 to $100,000. A bond election will probably be called as soon as arrangements can be perfected.

INCORPORATIONS.

Los Angeles, Cal.—Articles of incorporation of the Los Angeles & Owens River Railway have been filed, with a capital stock of $10,000,000, of which amount there has been subscribed $360,800. The directors of the company are Wm. J. Hunsaker, A. M. Chaffey and Geo. B. Reeve, all of this city.

Redwood City, Cal.—Articles of incorporation of the Cherry Canyon Water Company, which is organized with a capital stock of $200,000, have been filed. The directors of the new company are Henry P. Bowie, E. D. Beylard, George H. Howard, Duncan Hayne and J. H. P. Howard.

San Francisco, Cal.—The W. K. Oil Company has been incorporated with a capital stock of $500,000 by C. G. Wilcox, A. Crowley, J. W. Crowley, J. W. Nier, Geo. Barber, H. C. Kerr, W. C. Reilly. Place of business, San Francisco.

San Francisco, Cal.—Arline Oil Company has been incorporated with a capital stock of $480,000 by Geo. W. McNear, T. R. Turner, J. W. Pauson, Frank Pauson, J. Barneson, Ben Lowenstein, R. H. Smith.

San Francisco, Cal.—The Pauson Oil Company has been incorporated with a capital stock of $100,000 by T. R. Turner, J. W. Pauson, S. B. Pauson, Frank Pauson and Ben Lowenstein.

San Francisco, Cal.—The Turner Oil Company has been incorporated with a capital stock of $500,000 by T. R. Turner, J. W. Pauson, S. B. Pauson, Frank Pauson and W. H. Ingles.

ELECTRIC RAILWAYS.

Boise, Idaho.—The Boise & Interurban will build a line to Nampa, a distance of twenty miles.

Lewiston, Idaho.—The stockholders of the Lewiston & Southeastern electric line and of the Salmon River Power Co. voted an issue of $5,000,000 in bonds for the construction of the road and the development of the power plant. Of this issue $3,000,000 is for the railroad and $2,000,000 for the power development.

Spokane, Wash.—The Spokane & Pend d'Oreille Rapid Transit Co. will build a branch line to Spirit Lake. The line will be about twelve miles long.

Spokane, Wash.—The Spokane Traction Co. will put in double tracks on Sinto avenue, also on Second avenue, from Washington street east.

Walla Walla, Wash.—General Manager J. H. Morrow of the Columbia & Walla Walla Railway, states that the work of preparing maps of the line from Dayton to Wallulu is now completed and the building of the line is an assured fact.

Youngstown, Wash.—Contractor Smythe of the Seattle Electric Co. has a large force grading through this place for the proposed extension of the company's line to West Seattle. Half a mile has been graded out of this place. Three pile drivers are putting piles along Spokane avenue bridge for the new electric line.

Bellingham, Wash.—Actual work on the extension of the Dock and Garden street car lines is now under way. The Dock street line will be extended to North street, while the Garden street cars will run to Fourteenth street.

Portland, Ore.—Work has been commenced at Hood and Gibbs streets by the Willamette Valley Traction Co. to construct the city portion of the Portland-Salem line.

Spokane, Wash.—Clarence C. Ward, an attorney of St. Louis, is in the city and announces that capitalists of that city and London will furnish the funds for the construction of the Spokane & Big Bend Electric Railway Co., of which W. H. Plummer, of this city, is president.

Tacoma, Wash.—Steps preliminary to paralleling the principal lines of the Tacoma Railway & Power Co. were taken by the Pacific Traction Co., when three applications for franchises were presented to the City Council. The routes outlined indicate the paralleling of the Point Defiance and Sixth avenue lines of the Tacoma Railway & Power Co., and also a direct line to South Tacoma.

Tacoma, Wash.—The Pacific Traction Co. has applied to the City Council for a franchise across the tide flats.

Walla Walla, Wash.—David Eecles, President of the Sumpter Valley Railway, offers to build the railroad from Baker City to Eagle Valley, providing the total subscription of $100,000 is raised.

San Francisco, Cal.—William Muir has directed a communication to the Board relative to the choice of a Sierra water supply for San Francisco. Supplementary to the former offer for $29,000,000 of the waters of the middle and north forks of the American river, together with the necessary impounding and transmitting plant, Mr. Muir made a straight offer of the water rights along for $4,000,000. The letter was referred to the special water committee.

La Habra, Cal.—Truman Berry and C. V. Harvey have purchased 800 acres of land and state that they will develop water, install a pumping plant and subdivide the acreage in small tracts suitable for walnut and citrus ranches.

Orange, Cal.—Bids for supplying pumps as per specifications have been received from J. S. Smith Machinery Company, L. Booth & Sons and the Baker Iron Works.

RAILWAY NOTES.

Burns, Ore.—Right of way maps covering the distance from Vale to this end of the Crane creek gap for the Oregon Eastern Railroad, were filed in the local land office here.

Billings, Mont.—Twohy Bros. have the contract for building the largest tunnel on the Billings & Northern Railway, twelve miles from this place.

Hover, Wash.—Orders have been issued to the civil engineers on the Portland & Seattle line, now building through Hover, to set grade stakes for the double tracking of the line from a point four miles west of this place to Kennewick. Similar orders have been issued to the division engineers at work on the line between Vancouver and Cape Horn.

Eugene, Ore.—It is reported that George Gould has purchased the Corvallis & Eastern and the Astoria & Columbia Railways, and will extend the Corvallis & Eastern to Lakeview.

Newport, Ore.—The extension of the Corvallis & Eastern Railway from its present terminus at Yaquina to Newport, a distance of six miles, is officially announced by Guy W. Talbot, General Manager of the company.

Seattle, Wash.—Next spring will see the preliminary survey being made in Alaska for the railroad to be built from the Coast to the Copper River country by the Guggenheim brothers of New York. Neither the starting point of the railroad on the Coast nor the interior terminus have as yet been decided upon, but the road will not be less than 300 nor more than 600 miles long.

Spokane, Wash.—Seattle mining and railroad men, headed by Dr. J. F. Reddy, are negotiating for the purchase of the right of way and survey of the California & Oregon Coast Railway. This company planned to build a railroad from Grants Pass to Crescent City, Cal.

Boise City.—The building of the Idaho, Montana & California Railroad is now said to be an assured fact and work will begin on the grading in a week or less. The new officials have established offices at Caldwell, I., and will make Idaho their headquarters.

Springdale, Wash.—Track laying on the logging railroad being built from this place by the Sawmill Phoenix Co. of Spokane is expected to commence next week, the first two miles of the roadbed being ready for rails.

Livingston, Mont.—The Northern Pacific Railway, between Livingston and Bozeman tunnel, a distance of eleven miles, is to be straightened and double tracked. The contract, which will call for the expenditure of $1,000,000, has just been awarded to Deeks & Deeks, St. Paul.

Portland, Ore.—Authoritative information has been received from San Francisco confirming the sale of the California & Northeastern to the Southern Pacific, also that the construction of the line from Goose Lake to Klamath, with final connection with the main line at Eugene, will be carried through without delay.

Seattle, Wash.—Fifteen grading camps have been established along the route of the Milwaukee, between Snoqualmie Pass and the city power station. The tunnel and all rock work will be continued during the winter.

Spokane, Wash.—It is stated definitely that the Northern Pacific and Great Northern Railway Companies are to build a double track around the northern part of the city.

Vancouver, B. C.—Harriman will build a railroad from Vancouver to Ilwaco, a distance of 120 miles, along the north bank of the Columbia River. Official announcement of this has been made at Portland. The project will be backed by the Columbia Valley and Wallulu Pacific Railroads, representing the Union Pacific.

POWER AND LIGHT PLANTS.

Boise, Idaho—The Mickie Electric Co. of this city was given the contract for the construction of the power line from the Grantz power plant on the Payette to Centerville. The contract price is $10,000.

Bellingham, Wash.—The Reid Bros. Co. has been awarded the contract for building the smokestacks and boilers for the substation for the Columbia Improvement Co. power plant to be constructed in the near future in this city.

Granite Falls, Wash.—J. T. McChesney of the Everett Improvement Co. states that his company has decided to build a power plant at the falls.

Spokane, Wash.—The Big Bend Water Power Co., which is building a power plant on the Spokane River 28 miles northwest of Spokane, has already expended $15,000 on the work and is now seeking to interest additional capital in the enterprise to carry it to completion. About 16,000 horsepower can be developed at a cost of $21.90 per horsepower.

Missoula, Mont.—Prof. Robert Sibley will leave at once for the Bitter Roots to lay out the location for a new high pressure power plant for A. M. Holter of Helena. It is Mr. Holter's purpose to use the whole of Big creek at a pressure of 500 feet, therefore developing over 1,000 horsepower.

Spokane, Wash.—Frank MacKean of Chicago has a contract to build a $2,000,000 electric light plant for the Spokane Western Power & Traction Co. to develop 20,000 horsepower.

Weiser, Idaho—The Idaho Light & Power Co., which contemplates installing electric lights in Payette, Weiser and Ontario, is securing a right of way for its power ditch. The power house will be located four miles above Payette.

Dawson, Alaska—Three applications have been filed in the gold commissioner's office for water rights on the Twelve Mile river, approximating a total of 125,000 inches. The first was made by L. S. Robe, H. G. Wilson and F. J. Stackpoole for a period of 20 years, to be used in the generating of electricity for all kinds of machinery and transportation. The second by the Twelve-Mile Power Co., limited, by Messrs. Robe, Wilson and Stackpoole, to be for 20 years and applied to the same purpose. The third by A. N. C. Treadgold for a period of 20 years, and is intended for mining purposes on claims on Bonanza creek and hydraulic properties on the banks of the Klondike river.

Missoula, Mont.—A. M. Holter of Helena will build a power plant near Victor to develop 1,000 horsepower.

Portland, Ore.—The Portland & Sandy River Co. has been incorporated by Dan J. Malarkey and M. T. Donahoe with a capital of $100,000 and will construct an electric light plant on the Sandy river.

Sandpoint, Idaho—The Pend d'Oreille Electric Co. will install a new engine of 266 horsepower and boiler of 100 horsepower; also the development of water power, the erection of a transmission line 16 miles in length. J. F. Reynard, manager.

Tacoma, Wash.—H. B. Wales and Attorney Merrick of Grand Rapids, Mich., are in the city making arrangements for the establishment of a gas plant. H. B. Wales is general manager for the Dean Syndicate, the new owners of the Tacoma Gas Co.

Tacoma, Wash.—The contract for 65 transformers averaging from 7½ to 20 kilowatts was awarded to the General Electric Co. for $6,500, the lowest price ever made so far as known on the Pacific Coast. Other bids were Stanley Electric Co., $7,364; Bates & Clark, $7,240.

Monrovia, Cal.—W. A. White, manager of the Edison Electric Company, has stated that a force of men will soon begin work on the rebuilding of the gas plant. The system of production will be changed and the capacity slightly increased.

TELEPHONE AND TELEGRAPH.

Bellingham, Wash—Wires are being strung by the Home Telephone Co. Superintendent Middleton announced that the automatic system would not be in operation until February.

Boise, Idaho.—G. F. Chaple, manager of the R. M. Bell Telephone Co., states that a toll station will be established at Given's Hot Springs, on the Snake river.

Coeur d'Alene, Idaho—It is reported that the Interstate telephone line may change hands. Charles F. Walker and Charles F. Sloans, of San Francisco, are inspecting the property.

Centralia, Wash.—County Commissioners have granted the right to the Hanaford Valley Telephone Co. to erect a telephone line from the east end of the Hanaford road to this city.

Dawson, Yukon Territory—The Dawson Board of Trade will urge the federal government at Ottawa to install the Marconi system to connect Yukon with the outside world.

Missoula, Mont.—This city will be made headquarters for the western Montana division of the R. M. Bell Telephone Co., and will include the exchanges west of Drummond to the state line and the Bitter Root valley.

Marshfield, Ore.—Robertson & Gregor will extend their telephone line from here to North Bend and on to Tenmile.

Nez Perce, Idaho—C. L. Wilson of the Pacific States Telephone Co. has secured all the farmer lines extending out of here, and has worked up five other lines to be built this fall. The W. J. Ramey private line will also connect with the Pacific States Co.

Rainier Beach, Wash.—Manager Marsh of the Citizens' Telephone Co. states he will have a complete service installed as far as Taylor's mill within another week.

Seattle, Wash.—The Alaskan cable connecting Ketchikan and Wranger will be laid some time in September, according to Lieutenant Colonel Glassford. The work is to be done by the cableship Burnside, which is now at Tacoma undergoing extensive repairs and alterations.

Tacoma, Wash.—Russell & Babcock have drawn plans for the telephone building to be erected on South D street, near Ninth, at a cost of $60,000.

Washoe, Idaho—The Independent Telephone Co. will build a line to the new brick and tile factory across the Snake river.

Garfield, Wash.—The Pacific States Telephone Co. now controls all but four of the rural lines in the Palouse country.

Vallejo, Cal.—Master Electrician George H. Hanscome of the Mare Island yard has gone to the Farallone Islands in charge of a force of electricians to install another wireless station on the islands. The station now on that island has never given the satisfaction that it should.

San Francisco, Cal.—As part of the restoration of the telephone system in this city, the Pacific States Telephone & Telegraph Company has announced that the "east" exchange office, on Hyde street, near Sutter, will be in running order in about two weeks. At that time about 1,500 lines will be transferred from "main" exchange office on Bush street to the "east" office. The "east" office will serve the district west of Powell street and north of Market street, including Van Ness avenue, which is now being served by "west" and Bush street exchange offices. The district served by "east" office will be ultimately extended to Gough street, thus relieving the congestion at both these offices. The "east" office switchboard will have a capacity of 3,000 lines, which will be doubled as soon as the necessary material arrives.